Mexico Freight Assessment

GLOBAL GREEN FREIGHT ACTION PLAN

The International Council on Clean Transportation (ICCT)

Final Report

MEXICO FREIGHT ASSESSMENT GLOBAL GREEN FREIGHT ACTION PLAN

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Abbreviations

3PL	Third-party logistics company
AMDA	Asociación Mexicana de Distribuidores de Automotores
AMIA	Asociación Mexicana de La Industria Automotriz
AMMPAC	Asociación Mexicana de Mensajería y Paquetería A.C.
ANPACT	Asociación Nacional de Productores de Autobuses, Camiones y Tractocamiones
ANTP	Asociación Nacional del Transporte Privado
CANACAR	Camera Nacional del Autotransporte de Carga
CANACINTRA	Cámara Nacional de la Industria de Transformación
CCAC	Climate and Clean Air Coalition
CESPEDES	Consejo Empresarial para el Desarrollo Sostenible
CO	Carbon monoxide
CO_2	Carbon dioxide
CONATRAM	Confederación Nacional de Transportistas Mexicanos
CONCAMIN	Confederación de Cámaras Industriales
DGAF	Dirección General de Autotransporte Federal
DGGCARETC	Dirección General de Gestión de la Calidad del Aire y Registro de Emisiones y Transferencia de Contaminantes
EMBARQ	EMBARQ is now the WRI Ross Center for Sustainable Cities
EPA	United States Environmental Protection Agency
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HC	hydrocarbons
ICCT	International Council on Clean Transportation
INECC	Instituto Nacional de Ecologia y Cambio Climatico
ITDP	Institute for Transportation and Development Policy
MN	Moneda Nacional (Mexican pesos)
NAFTA	North American Free Trade Agreement
NAMA	Nationally Appropriate Mitigation Actions
NGO	Non-governmental organization
NOM	Norma Oficial Mexicana
NOx	nitrogen oxides
OEM	Original Equipment Manufacturer
PM	particulate matter
SCT	Secretaría de Comunicaciones y Transportes
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales
SHCP-SAT	Servicio de Administración Tributaria de la Secretaría de Hacienda y Crédito Público
SMAEM	Secretaría de Medio Ambiente del Estado de Mexico
Smartway	US EPA's SmartWay Transport Partnership
TELMEX	Telefonos de Mexico
TPP	Transpacific Association Agreement
Transporte Limpio	Voluntary Clean Transport program developed by SEMARNAT and SCT.
TSTES	The Sustainable Transport and Emissions Services Company
UNFCC	United Nations Framework Convention on Climate Change

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This report has been prepared for the International Council on Clean Transportation (ICCT) by the Sustainable Transport and Emissions Services Company (TSTES SA de CV) in collaboration with Integrated Transport Planning Ltd.

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A special thank you is particularly due to Ing. Judith Trujillo Machado, Subdirectora del Sector Transporte de SEMARNAT whose help, guidance, and support was key to realizing this study.

A sincere expression of gratitude is due to Mackay & Company, Lombard, Illinois who permitted us to share the most recent vehicle fleet data from the latest (2015) DataMac-Mexico study performed by TSTES. This study involves information collected from almost 5000 fleets together with an in-depth analysis of heavy duty fleet utilization (including Class 8 highway tractors and trailers) and repair practices in Mexico. It has been conducted every four years since 1992 and provides—amongst other things—a detailed view of the active vehicle fleet, which differs considerably from the static, registered vehicle distribution

The authors would additionally like to thank the Instituto Nacional de Ecologia y Cambio Climatico (INECC) for allowing us to quote findings from the study a performed for them by TSTES (2011) entitled "Caracterización de la flota mexicana de vehículos" and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH for allowing us to quote findings from the two-part 2014 study performed for them by TSTES looked at commercial vehicle scrappage programs in Mexico, and compared to those in other countries.

The study would not have been possible without input from fleets and other governmental and non-governmental organizations. There were obtained in person-to-person interviews and a quantitative field survey designed to (a) to fill data gaps, (b) refresh some of the older information, and (c) validate where previous findings are still functional.

The participants included in each group are shown below;

Interviews

Name	Company / Institution	Functionl
Adrián Azuara Perdomo	Daimler Vehículos Comerciales México (Freightliner)	Gerente de Ventas
Adulfo Vidals Rosas	Coca-Cola FEMSA	Coord. Ctrol. Ambiental
Alejandro Fuentes Romero	Great Dane de México	Director de Ventas,
Alex Long Theissen	Femsa Logística	Presidente de la Asociación Nacional de Transporte Privado y Director técnico de Femsa Logística
Alfonso Ayala Colín	Transportes Ayala Colín SA de CV	Director
Arturo Massutier Morales	Asociación Nacional de Productores de Autobuses, Camiones y Tractocamiones	Former manager
Carlos Gil Jiménez	Dirección General del Autotransporte Federal SCT	Subdirección de Desarrollo Tecnológico y Seguridad
Christan Sánchez Santoyo	PETSTAR	Administrador Transporte
Claudio Gallegos	Confederación Nacional de Transportistas Mexicanos (COTRAM)	Director General
Cristina Sánchez	Transportes Elola	Coordinadora CTPA OEA
Daniel García C.	Tracusa la Ruta del Sol	Cacacitación
Daniela Villarreal	Coca-Cola FEMSA Logistica	Relaciones Institucionales
David Herrera López Portillo	Auto Transportes Parada Hermanos	Coordinador de Tráfico
Elena Zaldivar	Auto Express Frontera Norte	Gerente de Calidad
Elizabeth Ramírez	Autotransportes de Carga Tresguerras	Ejec. Comercial
Fabiola Domínguez V.	Tracusa la Ruta del Sol	Jefe C Diesel
Felipe Jiménez	Auto Transporte Nacional de Carga TNC	Gte. Operaciones
Francisco Barrera	SMA EdoMex	Director de Investigacion e Implementacion de protocolos
Gabriel De Uriarte Occelli	Utility Trailers de México	Director Comercial Corporativo
Ignacio de Jesús Montoya Ayón	Bimbo - Barcel	Gerente de Estudios Técnicos
Isabel Aguiñaga	Autotransportes de Carga Tresguerras	Jefe Comercial México
Jaime Caracheo R.	Transportes Especializados Antonio de la Torre e Hijos	Coordinador SHMA
Javier Padilla Martínez	Bio Pappel	Gerente de Logística

Name	Company / Institution	Functionl
José Antonio Cortes Méndez	Alas del Monte	Gerente de Mantenimiento
Juan Manuel Flores Estrada	Auto Tanques Ochoa (ATOSA)	Coordinador
Juan Manuel Salas Martínez	Transcooler	Gerente de operaciones
Judith Trujillo Machado	SEMARNAT	Subdirectora del Sector Transporte
Karina Villegas	Transportadora Consolidada	Especialista en Marketing
Leonardo Núñez	Transportes Mexamerik	Gte. Operaciones
Luciano Aguilar Corona	Ferrocarril y Terminal Valle de México (FERROVALLE)	Gerente de Operaciones
Luis Enrique Ramírez	Transportadora Consolidada	Especialista de Transporte Limpio
Luis Rubén Flores Tapia	Coca-Cola FEMSA	Gte. Control Ambiental
Maribel del Carmen Peña Laurencio	Alas del Monte	Lic. Amb.
Maricela Hernández Horta	Tracusa la Ruta del Sol	Controller operaciones Corporativo
Moisés David Tellez	Transportes Elola	Director de Operaciones
Moises Ocaña	Fletes y Transportes Ruíz	Analista
Monserrat Rodríguez García	Autotransportes OILSA	Jefe de Procesos
Omar García Curiel	Transportes Especializados Antonio de la Torre e Hijos	SHMA
Oswaldo Muñoz	Flechisa	Ventas
Pablo Jesús Mercado	SCT	Director de Normatividad
Pedro Meneses Retalsa	Cemex	Rep. Legal
Rafael Tapia Velázquez	Grupo Bimbo	Dirección de Vehículos
Roberto Melchor	Fletes y Transportes Ruíz	Jefe de Mantenimiento
Rodolfo Rodríguez Jiménez	Tracomex, S.A. De C.V.	Gte. de operaciones
Rodrigo Perrusquía Máximo	SEMARNAT	Jefe de Departamento de Gestión Ambiental del Sector Transporte
Sergio Zirath	INECC	Director de investigación sobre la calidad del aire y los contaminantes climáticos de vida corta

Field Survey Participants

Fleet / Company	Fleet / Company	Fleet / Company
Aguilas Del Sureste	Geodis Global Solutions México S.A. de C.V.	Transportes Ayala Colín S.A. de C.V.
Alas Del Monte S. A. de C.V.	López Domínguez	Transportes Beltrán
Auto Express Frontera Norte S.A. de C.V.	Luis Altamirano	Transportes Botello
Autotransportes Oilsa S.A. De C.V	Mejía Rodríguez	Transportes De Carga Fortín
Bimbo S.A. de C.V.	Méndez	Transportes Elola, S.A. de C.V.
Bio Pappel, S.A. de C.V.	Ortega Materiales	Transportes Fuentes
Cemex Transporte	Petstar Reciclado (Avangard Mexico S de RL de CV)	Transportes Hernández
César Hernández	T.P.	Transportes Mares
Desperdicio Industrial Delgado	Tds, S.A. De C:V.	Transportes Mexamerik,S.A. de C.V.
Destino Express	Tracomex S.A. de C.V.	Transportes Mon-Ro, S.A. de C.V.
Diaz	Transcooler	Transportes Parra
Estafeta Mexicana S.A. de C.V. Y Empresas Filiales	Transportadora Consolidada S.A. de C.V.	Transportes Roldán
Femsa Logística	Transportec	Transportes Y Mudanzas Ruíz
Fletes Y Transportes Ruiz	Transportes Angeles	Trasesu
Forrajes Madrigal	Transportes Auto Tanques Ochoa, S.A. de C.V.	

The study was coordinated by John Rogers of TSTES; Robin Kaenzig (ITP) led the International and SmartWay analysis assisted by Ruby Stringer and other members of the ITP team. The field survey and interviews were organized and conducted by Javier Rodriguez (TSTES) with support from Arturo Massutier (GRUIDCO), Jaime Meza (TSTES) and other members of the team. Steven J. Rogers (TSTES) managed interview analysis and editorial activities.

Chapter 1:-Executive Summary

This Mexico Freight Assessment was conducted in 2017 for the International Council on Clean Transportation (ICCT) by the Sustainable Transport and Emissions Services Company, TSTES SA de CV, Mexico in conjunction with Integrated Transport Planning Ltd, England.

ICCT sponsored this project to assess the freight system in Mexico, with a focus on on-road goods movement, as a key contributor to the Climate and Clean Air Coalition's (CCAC) Global Green Freight Action Plan focused on developing and harmonizing green freight efforts on a global scale in order to get maximum reductions of black carbon and improved efficiency from freight transport.

The primary motivation for this project was to develop a much deeper understanding of the on-road freight system in Mexico. This freight assessment builds up the knowledge base in several areas, including market dynamics, opportunities and barriers for truck fuel-saving technologies and operational measures, and the potential benefits of building a more robust and extensive Transporte Limpio program, and harmonizing it with SmartWay.

The scope of the project was exclusively focused on freight transportation by tractor-trailers, and inclusive of the various actors that impact the freight system. This research looks to present a compendium of knowledge to government agencies and other stakeholders in Mexico who are developing strategies for reducing the environmental impacts of the trucking sector and give these decision-makers better tools to evaluate how a green freight program fits into the overall portfolio of policies aimed at the freight sector.

The study compiles publicly available data with findings from previous studies conducted by TSTES (and included with original client agreement) and input from fleets and other governmental and non-governmental organizations. Information was gathered from person-to-person interviews and a limited quantitative field survey with 89 stakeholders from different levels of the on-road freight system in Mexico to (a) fill data gaps, (b) update older information, and (c) validate previous findings where adequate. Although resource constraints prevented a statistically significant analysis of answers, the study provides the most recent data available on the Mexican on-road freight sector.

This data is collated into 8 thematic groups, (in Chapters 2 through 9) and a highlight of each is presented at the beginning of the corresponding chapters:

An ANNEX provides information on the Approach and Methodology and how the active population of Highway Tractors was determined.

Chapter 2:-Freight context in Mexico and the USA

This chapter compiles information on freight transport in Mexico by mode (Road, Rail, Waterborne and Air) to set the context for a more detailed evaluation of on-road freight transported by highway tractor-trailers.

Chapter Highlights

Overall freight market in Mexico
Although the overall freight market in Mexico is less than one-eleventh the size of that in the US (in terms of tonnes transported), the on-road share in Mexico is much greater accounting for 56 percent of the domestic and international freight transport and thus its relative importance to the economy is much larger. t-kmAverage transport distances in the US are twice as long as those in Mexico.

Road
According to the Ministry of Communications and Transport (SCT), Mexico invested more than US$ 2.05 billion in infrastructure in the first half of 2015. The current government has built 17 motorways (US$ 3.975 billion) and estimates that 35 more are required (US $ 7.2 billion). Over the last decade highway extension has increased at a combined 10-year average annual growth rate between 3.1 and 3.5 percent with a surge in 2015. This is higher than the overall freight market, which grew by 1.5 percent per year between 2005 and 2015. However, while the country is building new roads, maintenance of existing roads is below expectations which limits the efficiency of this sector. According to the World Economic Forum, among 140 nations, Mexico ranks 52nd in road quality competitiveness.

Rail
The second most important mode in terms of freight traffic in Mexico is Rail, which accounted for 30.5 billion t-kms of domestic freight in 2015 (versus 245 billion for Road). In 2015 there was a 3.4 percent increase in ton-kilometers transported by Rail, rising to 83.4 billion t-km (including import freight which grew by one third over the previous year). The main products transported by Rail are corn (11.8 percent), cement (8.3 percent), containers (7.5 percent) and iron and steel sheets and plates (6.3 percent). Over the last decades Rail energy efficiency has generally improved to its current (2015) value of 118 t-km/L of diesel. This is similar to the fuel efficiency of rail freight in the USA in 1985. In 2015 the US Freight Rail fuel efficiency was 201 t-km/L (473 ton-miles per US gallon).

The main railroad companies - Ferrocarril de México (Ferromex) and Kansas City Southern of Mexico (KCSM) - were expected to invest about US$ 3 billion by 2020 to expand the traction of the locomotive fleet, as well as in the renovation of tracks and trains. Multimodal transport is considered an area of opportunity in national logistics to boost Mexico's development.

Sea
Mexico's principal ports are reaching the limit of their capacity and demand new investments.

Pipelines
Mexico's energy reform in 2013 opened the energy industry to various degrees of private participation and competition. One result has been a fast expansion in the use of imported gas, with U.S. gas imports as a percentage of total demand climbing from 8 percent in 2000 to around 44 percent in 2016 creating a fast expansion in the Mexican pipeline grid to handle this increased demand.

Air
Air tonnage pales in comparison to other modes (representing only 387 thousand tons in 2015) concentrated in 10 states.

Freight by mode in Mexico and the USA

Domestic Freight in Mexico and the USA

Although the overall freight market in Mexico is less than one-eleventh the size of that in the USA (in terms of tons transported: see Figure 1) [1], the on-road share is much greater accounting for 56 percent of the domestic and international freight transport and thus its relative importance to the economy is much larger. In 2015, 86 percent of domestic freight was carried by Road (compared to 48 percent in the USA); only 8 percent by Rail and 6 percent by Sea[2] (see Figure 2). Accounting for International freight[3], the proportion of Mexican freight by Sea and Rail increases to 31 percent and 13 percent, respectively, leaving Road with a mode share of 56 percent (Figure 3).

1 In 2013 the US domestic market was 6,710 vs 600 million metric tons in Mexico
2 The freight numbers in Mexico do not have comparable figures for pipeline transport, which is excluded.
3 International freight is that which has the good origin or destination in a different country. National freight has goods origin and destination within the same country. One third of all freight transported (in tons) in Mexico is international (import/export).

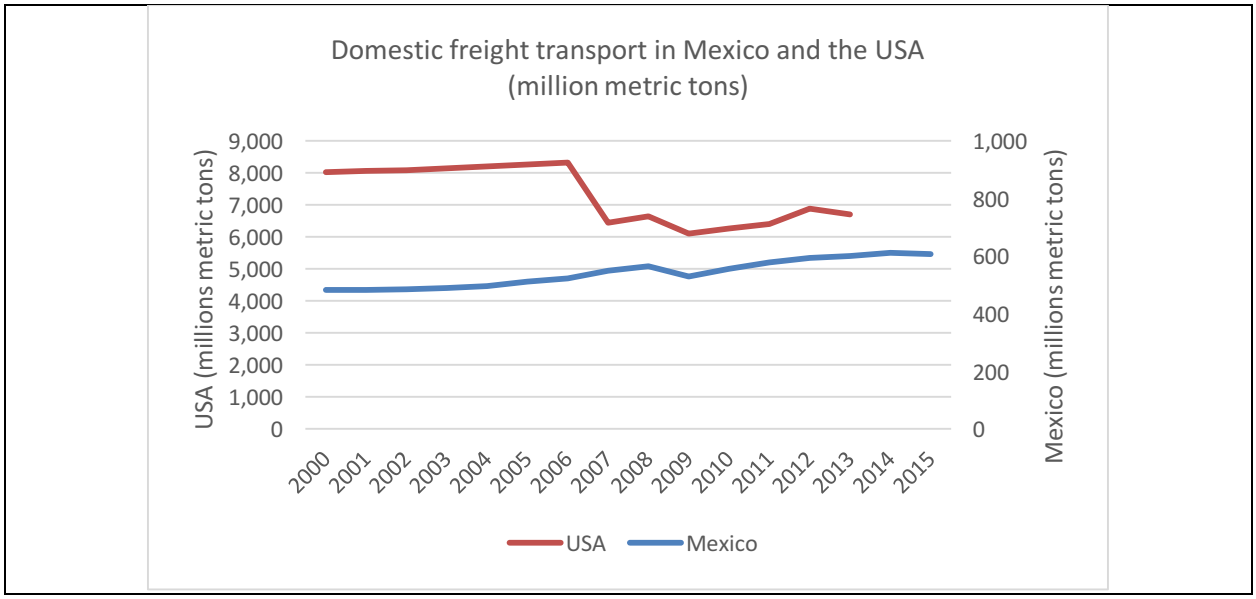
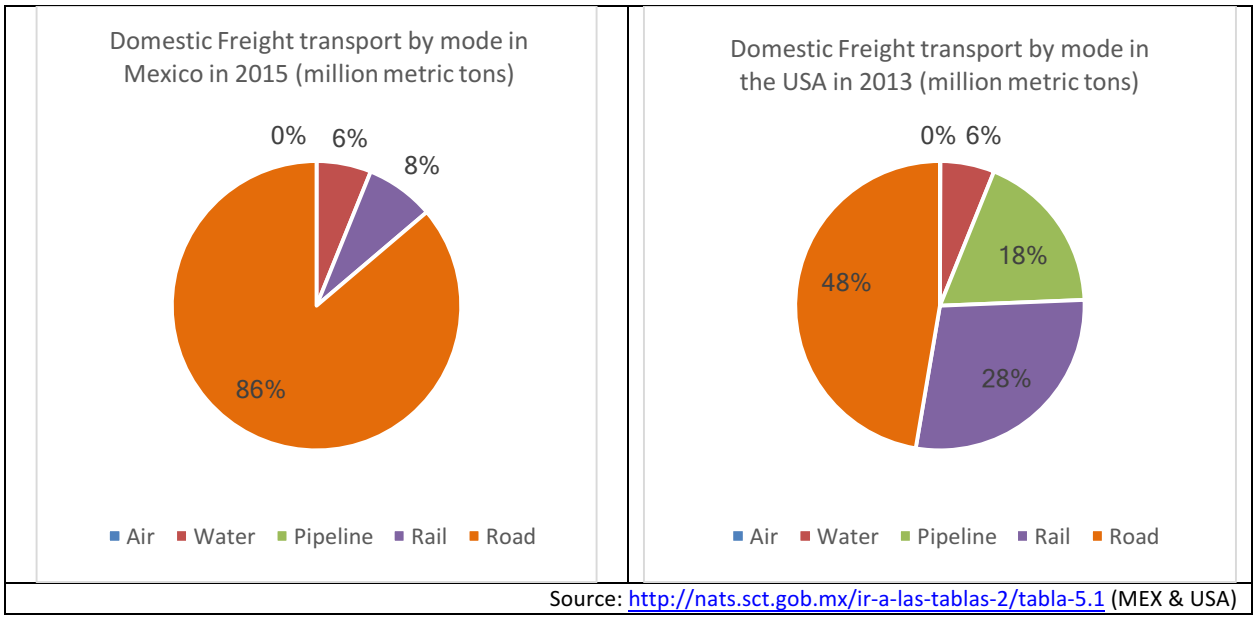
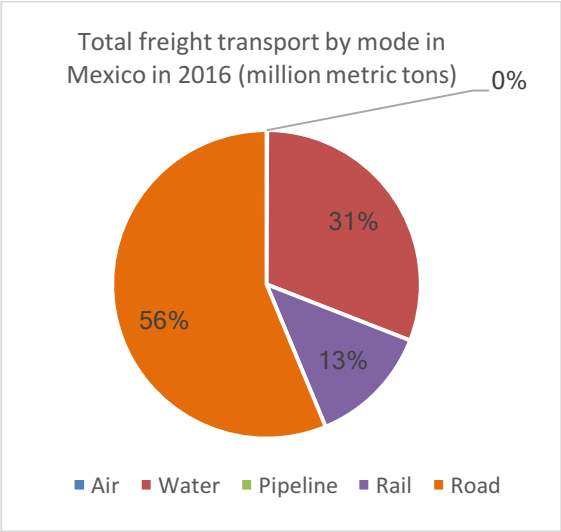


Figure 1 - Domestic freight transport in Mexico and the USA



Source: http://nats.sct.gob.mx/ir-a-las-tablas-2/tabla-5.1 (MEX & USA)

Figure 2 - Domestic freight transport by mode in Mexico and USA



Source: SCT Estadística Básica del Autotransporte Federal – 2016 and Tercer Informe de Gobierno (2015)[4]

Figure 3 - Total freight transport by mode in Mexico

Whilst freight is typically measured in tons, freight traffic (measured in ton-kilometers)[5] can be a better indicator for transport services. With this metric (t-km) the USA domestic freight traffic is over 22 times larger than the Mexican[6], showing that the average transport distances in the USA are twice as large as those in Mexico.

Whilst on-road domestic freight traffic is much less in absolute numbers in Mexico than in the USA (235 billion t-kms in Mexico vs 2,997 billion t-kms in the USA –2013), its relative importance is larger (see Figure 4).

[4] This figure adds to domestic freight Export/import by Air (0.5 Mt), Water (255.5 Mt) and Rail (73.1Mt), Road export/import estimated in approx. 60 Mt is already included in domestic traffic.
[5] See **Error! Reference source not found.**, Table 3, and Table 4
[6] 235 billion t-kms in Mexico vs 2,997 billion t-kms in the USA –2013 - see **Error! Reference source not found.**

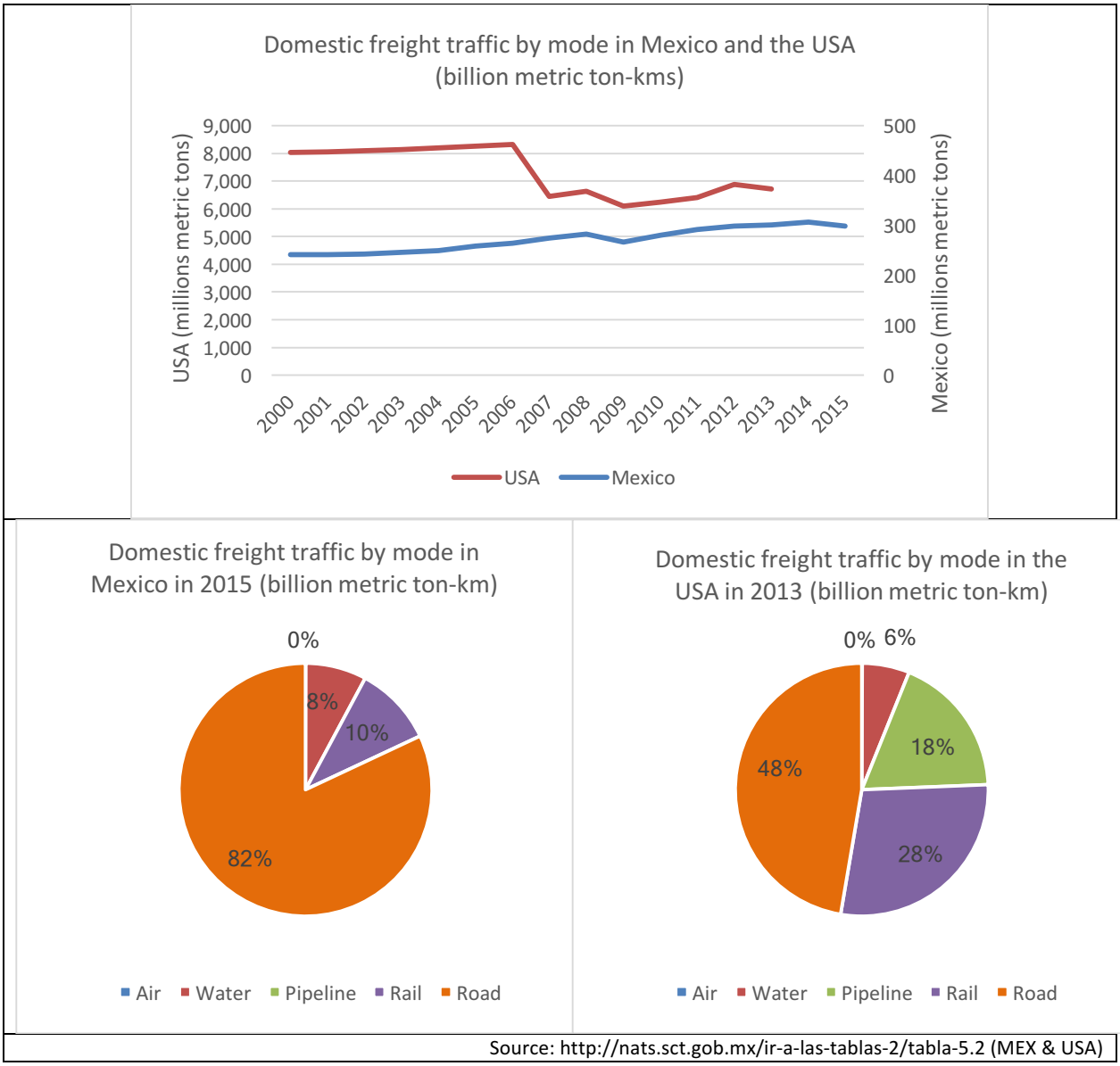


Figure 4 - Domestic freight traffic by mode in Mexico and the USA

The domestic freight market in Mexico (see Table 1 and Table 2) has exhibited continuous growth over the past 15 years, despite a slight contraction in 2009, with a 10-year annual growth rate (2005-2015) of 1.7 percent. By comparison, the USA domestic freight market suffered a major collapse due to the economic depression in 2007 from which it has not recovered. Its 10-year annual growth rate (2003-2013) has been -1.9 percent.

The most recent numbers for the USA (2013), show that 48 percent of domestic freight was carried by Road, 28 percent by Rail and 18 percent by Pipeline. Water accounted for 6 percent of the total tonnage.

Table 1 - Domestic freight transport by mode in Mexico

Domestic freight transport by mode in Mexico (millions metric tons)

	2000	2005	2010	2013	2014	2015
Air	0.1	0.1	0.1	0.1	0.1	0.1
Water	33.8	39.2	37.2	36.4	37.4	37.0
Pipeline						
Rail	36.2	36.9	48.1	61.6	62.8	46.6
Road	413.2	435.5	470.0	502.2	511.3	523.0
Total	483.3	511.7	555.4	600.3	611.6	606.7

Source: http://nats.sct.gob.mx/ir-a-las-tablas-2/tabla-5.1 (MEX & USA)

Table 2 - Domestic freight transport by mode in USA

Domestic freight transport by mode in USA (millions metric tons)

	2000	2005	2010	2013	2014	2015
Air	21.9	23.0	4.3	4.1		
Water	942.8	863.2	501.5	405.3		
Pipeline	1,355.1	1,370.5	1,218.9	1,225.3		
Rail	2,257.6	2,530.6	1,857.4	1,900.3		
Road	3,454.5	3,475.2	2,671.3	3,175.5		
Total	8,031.9	8,262.5	6,253.4	6,710.5		

Source: http://nats.sct.gob.mx/ir-a-las-tablas-2/tabla-5.1 (MEX & USA)

Table 3 - Domestic freight traffic by mode in Mexico

Domestic freight traffic by mode in Mexico (billion metric t-kms)

	2000	2005	2010	2013	2014	2015
Air	0.1	0.1	0.1	0.1	0.1	0.1
Water	21.3	24.7	23.5	23.0	23.6	23.3
Pipeline						
Rail	25.7	29.7	36.3	42.8	43.3	30.5
Road	194.1	204.2	220.3	235.4	239.7	245.1
Total	241.2	258.7	280.2	301.3	306.7	299.0

Source: http://nats.sct.gob.mx/ir-a-las-tablas-2/tabla-5.2 (MEX & USA)

Table 4 - Domestic freight transport by mode in USA

	2000	2005	2010	2013	2014	2015
Domestic freight transport by mode in USA (millions metric tons)						
Air	21.9	23.0	4.3	4.1		
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Total	8,031.9	8,262.5	6,253.4	6,710.5		

Source: http://nats.sct.gob.mx/ir-a-las-tablas-2/tabla-5.2 (MEX & USA)

Import and Export freight to USA and Canada

Table 5, and Table 6 show international trade with NAFTA countries and the world by major product group in 2014 (exports and imports, respectively). Over 80% of Mexico's total exports went to NAFTA trading partners, while imports came from a broader spectrum of countries (NAFTA partners contributed to 51 percent of imports).

Table 5 - EXPORT Merchandise trade of Mexico to NAFTA countries and the world by major product group, 2014

	World		NAFTA	
Exports (billion USD)	Value	Share	Value	Share
Mexico				
Agricultural	26	6.6	21	6.2
Fuels and mining	53	13.4	36	11.1
Manufactures	309	77.8	266	80.6
Total exports	398	100	330	100

Source: World Trade Organization International Trade Statistics 2015

Table 6- IMPORT Merchandise trade of Mexico from NAFTA countries and the world by major product group, 2014

	World		NAFTA	
Imports (billion USD)	Value	Share	Value	Share
Mexico				
Agricultural	31	7.5	24	11.5
Fuels and mining	44	10.6	34	16.2
Manufactures	326	79.2	149	70.3
Total imports	412	100	212	100

Source: World Trade Organization International Trade Statistics 2015

Table 7 shows the five principal ports of Entry/Exit with the USA and Canada by mode. In dollar terms, the principal ports of Road entry account for 65 percent of trade through principal ports. Rail handles one third of the Road value (22 percent), with Sea, Pipeline, and Air with much smaller participation.

Table 7 - Principal ports of Entry/Exit for freight to/from NAFTA trading partners

	Imports from:			Exports to:		
Millions of USD	Canada	USA	Sum	Canada	USA	Sum
Air						
CD. DE MEXICO D.F.	70	2,184	2,254	3,060	3,372	6,432
GUADALAJARA JAL.	326	3,222	3,548	1,270	1,430	2,700
MONTERREY N.L.	24	585	609	266	287	553
PROGRESO YUC.	41	688	729	627	646	1,273
TOLUCA MEX.	57	564	621	412	474	886
Sea						
ALTAMIRA TAMPS.	18	1,137	1,155	2,625	2,660	5,285
CD. DEL CARMEN CAMP.		6,086	6,086	53	53	106
COATZACOALCOS VER.	88	2,404	2,492	5,633	5,642	11,275
TUXPAN VER.		2	2	5,652	5,688	11,340
VERACRUZ VER.	88	4,830	4,918	2,660	3,064	5,724
Road						
CD. JUAREZ CHIH.	386	44,462	44,848	17,923	18,405	36,328
CD. REYNOSA TAMPS.	208	19,685	19,893	7,928	8,273	16,201
COLOMBIA N.L.	1,148	21,870	23,018	9,354	9,849	19,203
NUEVO LAREDO TAMPS.	2,447	72,730	75,177	54,159	57,607	111,766
TIJUANA B.C.	641	30,206	30,847	12,255	12,610	24,865
Rail						
CD. JUAREZ CHIH.	384	7,229	7,613	2,267	2,524	10,138
MATAMOROSTAMPS.	14	320	334	630	631	967
NOGALES SON.	3	6,519	6,522	1,990	2,083	8,606
NUEVO LAREDO TAMPS.	3,324	18,915	22,239	16,281	17,627	39,867
PIEDRAS NEGRAS COAH.	497	15,536	16,033	6,619	7,202	23,236
Pipeline						
CD. CAMARGO TAMPS.			0	846	846	1,692
CD. JUAREZ CHIH.		16	16	1,686	1,687	3,373
CD. REYNOSA TAMPS.		216	216	677	677	1,354
MATAMOROSTAMPS.		11	11	1,144	1,144	2,288
MEXICALI B.C.		246	246	406	406	812

Source http://nats.sct.gob.mx/ir-a-las-tablas-2/tabla-6-

Transport Infrastructure in Mexico

Table 8 shows the extension of the infrastructure for each mode.

Table 8 - Transport Infrastructure in Mexico

		2000	2005	2010	2015	10yr CAGR
Road Network	000 kms	**323.1**	**355.8**	**371.9**	**390.3**	**0.9%**
Paved	000 kms	108.5	122.7	138.4	156.8	2.5%
Highways	000 kms	101.8	111.9	122.4	156.8	3.4%
Highways <4 lane	000 kms	91.6	100.7	109.8	141.5	3.5%
Highways >=4 lane	000 kms	10.2	11.2	12.6	15.3	3.1%
		..	..	..	..	
Unpaved	000 kms	214.6	233.1	233.5	233.5	0.0
Pipeline	000 kms	16.4	25.5	26.5	29.3	1.4%
Gas	000 kms	7.5	16.3	16.6	17.8	0.9%
Oil	000 kms	8.9	9.1	10.0	11.4	2.3%
Rail	000 kms	26.7	26.7	26.7	26.8	0.1%
Urban rail	000 kms	0.3	0.3	0.3	0.3	1.0%
Airports	number	1,215	1,485	1,465	1,489	0.0%
Ports	number	108	113	116	117	0.3%

Source: http://nats.sct.gob.mx/ir-a-las-tablas-2/tabla-11-infraestructura-para-el-transporte

10 year CAGR = combined average annual growth rate from 2005 to 2015

Road System

Given the importance of on-road freight to the economy, investment has been made in the road system (see Figure 5). Over the last decade highway extension has increased at a combined 10-year average annual growth rate between 3.1 and 3.5 percent with a surge in 2015 (see Table 8, Figure 6). Over the last 10 years, other modes have not exhibited significant growth.

According to the Ministry of Communications and Transport (SCT), Mexico invested more than US$2.05 billion in infrastructure in the first half of 2015. The current government has built 17 motorways

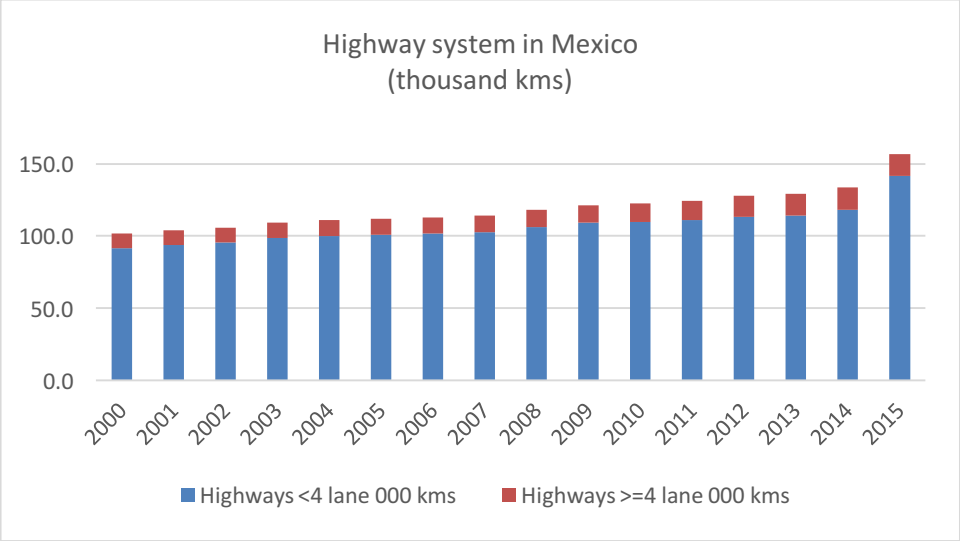
(equivalent to an investment of US$3.975 billion), and estimates that 35 more are required (equivalent to approximately US$7.2 billion)[7].

Despite investiment in road capacity, Mexico ranks 52nd in road quality competitiveness among 140 nations. Whilst the country is building new roads, maintenance of existing roads is below expectation which limits the efficiency of this sector[8].

Source: http://geo-mexico.com/?p=10053

Figure 5 - Principal Highways in Mexico

[7] Source: https://www.forbes.com.mx/mexico-invirtio-mas-de-33000-mdp-en-infraestructura-carretera
[8] Sources: World Economic Forum Competitiveness rankings 2014-2015 http://reports.weforum.org and http://www.elfinanciero.com.mx/empresas/se-estanca-calidad-de-carreteras-en-mexico-pese-a-mayor-inversion.html



Source: http://nats.sct.gob.mx/ir-a-las-tablas-2/tabla-11-infraestructura-para-el-transporte

Figure 6 - Highway system length in Mexico

Rail System

Mexico has not had an extensive rail system as seen in the United States or the European Union. The railway infrastructure consists of 26,727 kilometers of track, of which 20,722 are part of the trunk routes and their branches, and are mostly concessional. Of the remainder, 4,450 kilometers are secondary routes and 1,555 kilometers are private.

Rail competes favorably on high-volume, low-value shipments such as corn or cement and where specific market segments are served on specific routes, such as the automotive trains. The tractor-trailer is seen by transport companies as the better-connected, more flexible option. SCT, 3PL companies, and many others agree that if there could be significant investments in Rail transport, the system would be complementary to the current highway system in multi-modal operation, reducing costs and emissions from the longer-haul links but using on-road freight for first and last mile connections from suppliers and to the final destination. This would involve much improvement in the efficiency of the rail-road freight interconnections especially favoring movements above 400-500km.

According to the National Infrastructure Program (PNI) 2014-2018, railway service in Mexico has improved significantly in terms of management, rolling stock, capital and labor productivity, as well as the increase of traffic levels and market shares. The program proposes strengthening and expanding the service in some urban areas to increase infrastructure capacity and mobility. In addition, existing connections of the rail network of the Integral Port Administrations of freight can be improved to facilitate and increase container traffic. An objective of the PNI is to increase freight train speeds and expand railway infrastructure to have sufficient space for loading and unloading Rail freight.

Included in this program is the construction of the Celaya rail bypass, including a 19.4 km patio for rail-road freight interconnection and the short section of the Aguascalientes-Guadalajara railroad, the Manzanillo-Tampico and Manzanillo-Nuevo Laredo rail corridors. The latter will have a length of 188.1 kilometers, becoming a key player in freight movements between the Gulf and the Pacific and to the United States.

Likewise, it is envisaged in the NIP the modernization of the Chiapas-Mayab railroad, The Coatzacoalcos corridor and the use of the Trans peninsular Train.

Figure 7 - Rail infrastructure in Mexico

The main railroad companies: Ferrocarril de México (Ferromex) and Kansas City Southern of Mexico (KCSM) are expected to invest about USD 3 billion by 2020 to meet the new demand for rail freight. These were the largest budgets for these firms since the privatization of the national rail system over similar time periods, driven by the expected growth of the energy sector (due to the reform) and the impetus that was to be given to trade by the then-proposed Transpacific Association Agreement (TPP)[9].

[9] El Financiero 11 March, 2017 (http://www.elfinanciero.com.mx/empresas/ferromex-y-kcsm-invertiran-en-mexico-mil-mdd-al-2020.html)

The investments will be used to expand the traction of the locomotive fleet, as well as in the renovation of tracks and trains.

Despite these investments, most freight companies interviewed do not see Rail as competing with tractor-trailer trucks in Mexico. The level of Rail infrastructure investment to be able to compete with highway, for general freight, would be expensive and politically complex due to the concession system in place.

Multimodal freight

Freight terminals in Mexico must be authorized by the Ministry of Communications and Transport (SCT) and in addition to allowing the loading and unloading of freight between the railway and on-road transport, can provide services such as reception, storage, classification, consolidation, and dispatch of freight.

In 2015, there were 59 rail freight terminals operating with permits, mainly in the states of Nuevo León (25%), State of Mexico (15%), Jalisco (10%) Querétaro (10%), Hidalgo (8%) and S.L.P. (8%).

Multimodal transport is considered an area of opportunity in national logistics to boost Mexico's development. Both for the domestic market and exports, many multimodal trip lengths are greater than 400-500 kilometers, above which Rail, if properly exploited, can generate both cost and emissions savings[10.]

Pipelines

In December 2013, Mexico's energy reform opened the energy industry to various degrees of private participation and competition. This has not led to an increase in national gas production because more than half of Mexico's natural gas production is associated gas from oil and is located at the southern end of the country. Domestic gas supply has declined by nearly 0.9 billion cubic feet per day (Bcf/d) since 2010 to 4.1 Bcf/d in 2015 as oil production lagged, but at the same time, demand for gas picked up, mostly from the power sector, in which 1,990 MW of new combined cycle natural gas power plants will be installed, and pipeline imports from the U.S. have been utilized to balance the market.

To meet this demand, new pipelines are being built (see Table 9), and existing pipelines are being expanded or having their flow capability reversed. Gas imports from the U.S. accounted for only 8% of Mexican gas demand in 2000. By 2010, U.S. gas imports as a percentage of total demand climbed to 14%. In 2016 pipeline imports surged to around 44% and are expected to account for half, if not more, of total demand in 2017 and beyond. By the end of 2017, twelve new natural gas pipelines are expected

[10] Source: PNI and El Economista 29 April 2014 (http://eleconomista.com.mx/industrias/2014/04/29/transporte-multimodal-impulsara-desarrollo-mexico)

to be placed in service, facilitating natural gas export growth from the USA to Mexico and providing increased interconnectivity for the Mexican natural gas grid.

The expansions planned for the Mexican pipeline grid are intended to provide a long-term foundation for increased natural gas burn, with imports gradually increasing as projects are completed.

Table 9 - Construction of new pipelines in Mexico up to 2017

Year	New Pipelines (km)	Total Extension (km)
2010		11,542
2011	300	
2013	625	
2014	365	
2016	1,944	
2017	1,021	15,797

Source: Insights of Transportation & Logistics Sector in Mexico, PWC, Sept 2014 (https://www.pwc.com/mx/es/knowledge-center/archivo/2014-09-transportation-and-logistics.pdf)

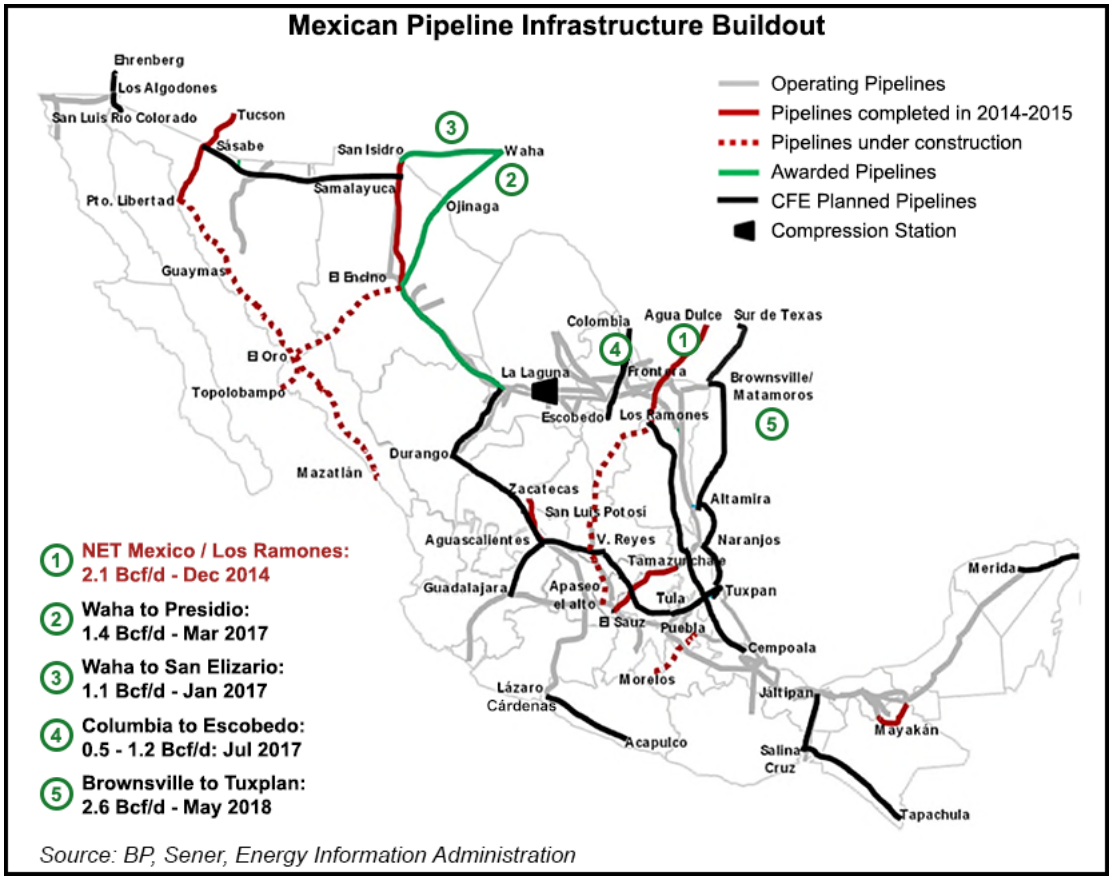
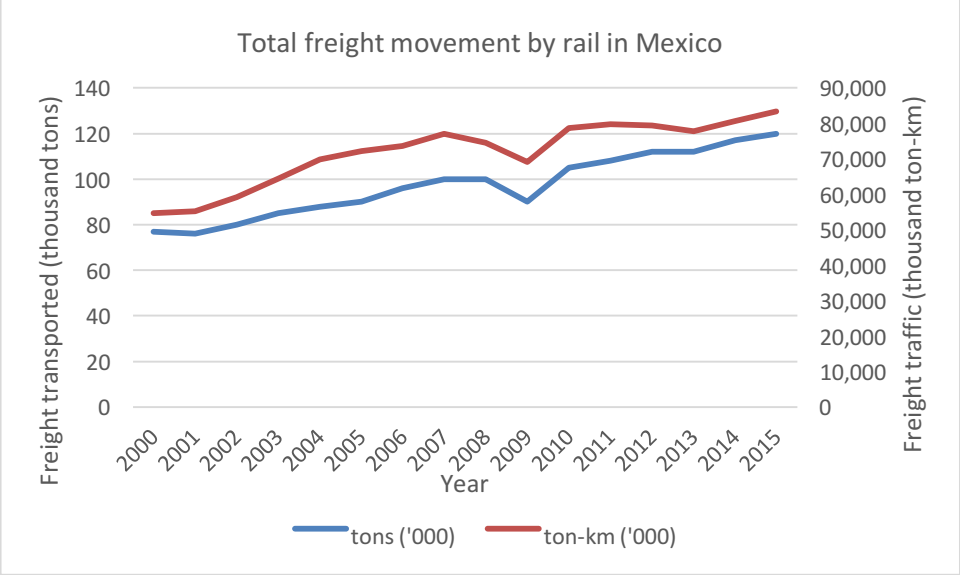


Figure 8 - Mexican pipeline infrastructure

Transport Activity by modes other than Road

Freight transported by Rail

In 2015, freight transport by Rail (seeFigure 9) increased by 2.3 percent compared to 2014, recording a movement of 119.6 million net tons. Likewise, there was a 3.4 percent increase in ton-kilometers transported, rising to 83.4 billion t-km in 2015. Similarly, Rail traffic of import cargo amounted to 54.9 million tons in 2015; an increase of 32.9 percent over the previous year. The main products transported by Rail (see Figure 10 and Table 10) are corn (11.8 percent), cement (8.3 percent), containers (7.5 percent) and iron and steel sheets and plates (6.3 percent).



Source: ANUARIO ESTADÍSTICO FERROVIARIO 2015 Dirección general de Transporte Ferroviario y Multimodal

Figure 9 - Freight transported by Rail in Mexico

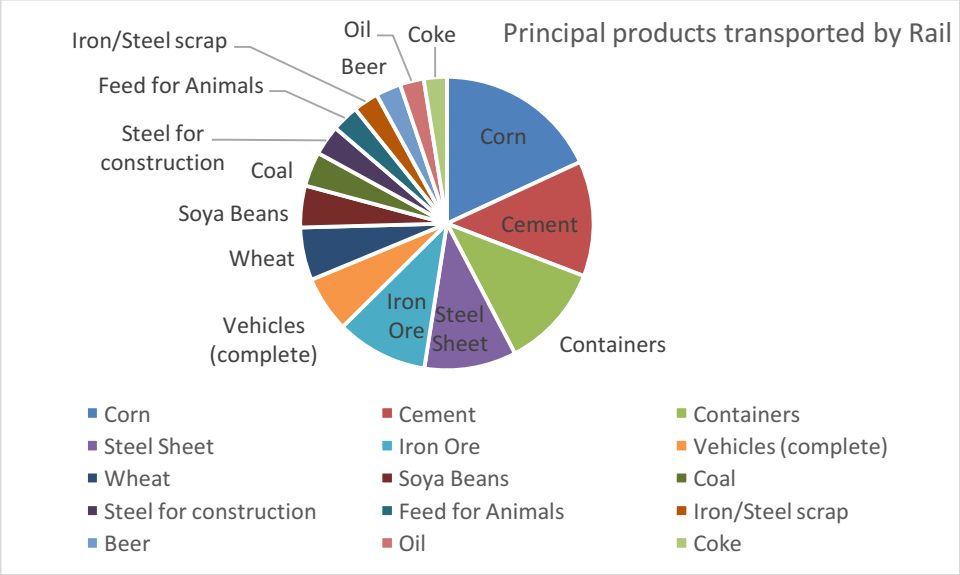


Figure 10 - Principal products transported by Rail

Table 10 - Principal products transported by Rail in Mexico

	Tons ('000)	%
Corn	14,062	11.80%
Cement	9,873	8.30%
Containers	8,930	7.50%
Steel Sheet	7,878	6.60%
Iron Ore	7,844	6.60%
Vehicles (complete)	4,795	4.00%
Wheat	4,523	3.80%
Soya Beans	3,573	3.00%
Coal	2,949	2.50%
Steel for construction	2,563	2.10%
Feed for Animals	2,317	1.90%
Iron/Steel scrap	2,170	1.80%
Beer	2,162	1.80%
Oil	2,039	1.70%
Coke	1,972	1.60%
Top 15	77,650	65.00%
Total	119,646	

Source: ANUARIO ESTADÍSTICO FERROVIARIO 2015 Dirección general de Transporte Ferroviario y Multimodal

Rail Energy Efficiency

Over the last decades the energy efficiency of Rail transport has improved to its current (2015) value of 118 t-km/L of diesel (Table 11 and Figure 11). This is equivalent to the freight rail fuel efficiency in the USA in 1985. In 2015 the USA Freight Rail Fuel Efficiency was 201 t-km/L (473 ton-miles per US gallon[11]). Whilst some locomotives and railcars may be similar to those used in the USA, track and signaling system limitations, together with topography and operating practices combine to limit specific fuel economy. In the USA, the exceptionally long average length of haul with unit trains of 50 or more wagons dedicated to a single commodity and shipper allow the trains to move through the rail network with a minimum of switching making transit times lower, more reliable and more fuel efficient[12].

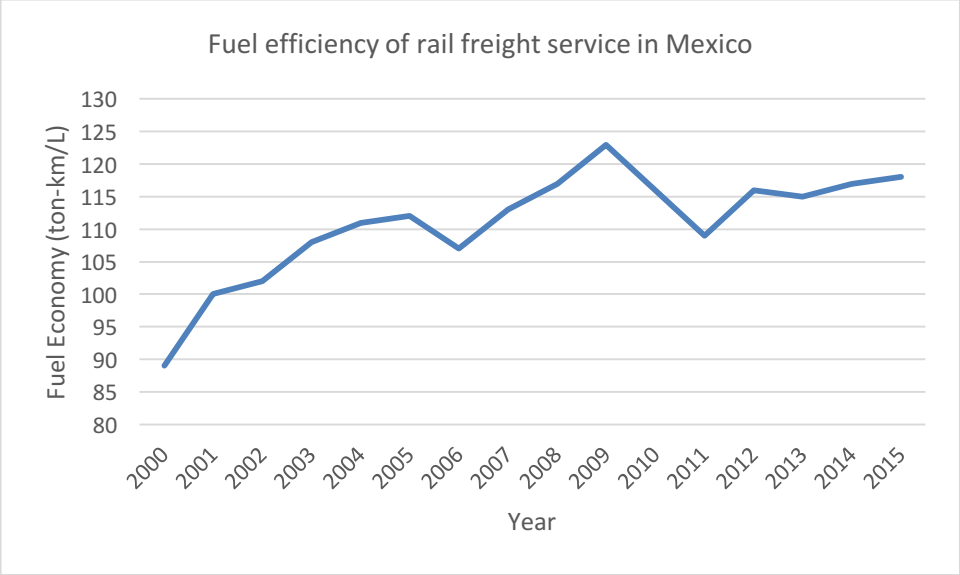
Table 11 - Freight transported by Rail and fuel efficiency in Mexico

		2000	2005	2010	2015
Freight Transported	Ton (million)	77	90	105	120
Freight Traffic	t-km (million)	54,776	72,185	78,770	83,401
Fuel consumed by freight trains	Litres (million)	617	642	678	709
Fuel Economy	t-km/L	89	112	116	118

Source: ANUARIO ESTADÍSTICO FERROVIARIO 2015 Dirección general de Transporte Ferroviario y Multimodal

[11] Source Association of American Railroads (https://www.aar.org/BackgroundPapers/Environmental%20Benefits%20of%20Moving%20Freight%20by%20Rail.pdf)

[12] Sources: Freight Railway Development in Mexico, International Transport Forum OECD, 2012 and Effects of North American Free Trade Agreement on Agriculture and the Rural Economy, Steve Zahniser and John Link. USDA WRS-02-1 July 2002



Source: ANUARIO ESTADÍSTICO FERROVIARIO 2015 Dirección general de Transporte Ferroviario y Multimodal

Figure 11 - Fuel efficiency of Rail freight service in Mexico

Principal ports by tonnage (national and International) 2015

For waterborne freight, domestic coastal shipping accounted for 26 percent of total tonnage with the remainder being international (export / import) trade (see Table 12). The most strategic ports for commercial cargo are Altamira, Veracruz, Manzanillo, and Lázaro Cárdenas, which together account for 95 percent of the containerized cargo, 59 percent of the agricultural bulk freight, 34 percent of the bulk minerals and 40 percent of the loose general cargo[13]. These ports are reaching their capacity[14] and demand new investments. There are 182 shipping lines operating in Mexican ports and around 15 percent of total cargo is containerized.

[13] Cayos Arcas is an off-shore oil terminal. The Arcas oil rigs are currently among the largest oil producers in the gulf in terms of output. Coatzacoalcos is dominated by the petrochemical sector. Four big industrial petrochemical complexes are located near the city (Pajaritos, Cosoleacaque, Morelos and Cangrejera) making it one of the most important concentrations of its kind in the world.

[14] Coordinación General de Puertos y Marina Mercante, Estadística mensual de Movimiento Portuario 2014.

Table 12 - Principal ports by freight tonnage in Mexico

	thousands of metric tons			
Port	Total	National	International	Containers as % of total
Cayo Arcas Campeche	41335	NS	41335	NA
Manzanillo Colima	28496	4154	24343	63
Lázaro Cárdenas Michoacán	28189	7256	20934	25
Coatzacoalcos Veracruz	28111	5289	22822	NS
Veracruz	21210	1411	19799	40
Altamira Tamaulipas	17314	11	17304	31
Isla de Cedros Baja California	17103	8125	8978	NA
Salina Cruz Oaxaca	13464	8315	5149	NS
Tuxpan Veracruz	12427	1591	10837	NS
Punta Venado Quintana Roo	10842	991	9851	NA
Dos Bocas Tabasco	10351	2962	7389	NS
Guerrero Negro Baja California Sur	8221	8213	8	NA
Guaymas Sonora	7831	4116	3714	1
Tampico Tamaulipas	6785	2415	4370	NS
Topolobampo Sinaloa	5939	3746	2193	NA
Progreso Yucatán	4252	1944	2308	10
Cuyutlán Colima	3481	NS	3481	NA
Mazatlán Sinaloa	3263	2368	895	12
Rosarito Baja California	2604	1425	1179	NA
Ensenada Baja California	2320	578	1742	37
Subtotal - 20 main ports	273539	64909	208630	15
Total all ports	286549	74713	211837	NA
20 main ports: % of total	95	87	98	14

Source: http://nats.sct.gob.mx/ir-a-las-tablas-2/tabla-11 Note: N/A not applicable, N/S not significant

Air Operations

Airfreight, as in the rest of the world, is typically dedicated to high-value, highly-perishable, time-sensitive, cargo and Air tonnage pales in comparison to other modes (representing only 387 thousand tons in 2015). However, its specific value is much higher than other modes as can be seen in Table 13.

96 percent of the airfreight in Mexico is concentrated in 10 states with Mexico City (Distrito Federal) being the most important and double that of Jalisco which is in second place. Mexico City, Guadalajara, Monterrey, and Laredo together account for 79 percent of airfreight. The principal routes for airfreight in Mexico by state are shown in Figure 12 and Table 14 respectively.

Table 13 - Yearly Trade Ratios of Value to Weight between USA - MEXICO (import value to the USA in current U.S. dollars and import weight in Kg)

Yearly Trade Ratios of Value to Weight between USA - MEXICO (import value to the USA in current U.S. dollars and import weight in Kg)

	2010	2011	2012	2013	2014	2015	2016
Air	159.68	168.86	159.96	132.26	133.09	132.63	131.9
Water	0.49	0.66	0.68	0.63	0.6	0.38	0.35
Pipeline	0.49	0.53	0.49	0.51	0.38	0.34	0.31
Rail	3.04	3.15	3.77	3.73	3.6	3.72	3.74
Truck	4.97	5.2	5.42	5.38	5.43	5.74	5.28

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, TransBorder Freight Data.

Source www.air7seas.com/

Figure 12 - Principal Air freight routes

Table 14 - Principal states for Air freight in Mexico

	Flights (passenger + freight)			Freight (thousand tons)		
	Scheduled	Charter	Total	Scheduled	Charter	Total
Distrito Federal / Mexico City	203,339	1,354	204,693	189.9	7.6	197.6
Jalisco	69,410	1,657	71,067	80.2	5.9	86.1
Nuevo León	50,119	1,196	51,315	17.0	4.9	21.9
San Luis Potosí	6,294	231	6,525	12.3	1.0	13.4
Yucatán	10,192	670	10,862	9.4	1.6	11.1
Baja California	28,104	403	28,507	9.5	0.9	10.4
Estado de México	5,716	195	5,911	8.5	0.2	8.6
Quintana Roo	73,608	3,137	76,745	7.5	0.5	8.1
Querétaro	5,374	1,497	6,871	0.0	7.4	7.5
Sonora	12,434	806	13,240	2.6	3.0	5.6
Total top 10			475,736	337.0	33.2	370.2
Total National			638,376			387.6
Top 10 as % of total			74.5%			95.5%

Source: SCT, SST, DGAC, DDE. Information provided by air carriers

Chapter 3:- Characteristics of In-use Tractor-trailers in Mexico

This chapter compiles information on the registered, and active in-use population of highway tractors and semi-trailers in Mexico. It presents data by size of fleet and by vocation, and looks at the expected life of these units.

Chapter Highlights

Population of In-use Highway Tractors

The national population of registered highway tractors at the end of 2016 is 284,349 units which has grown at an average rate of 4.6 percent per year over the last 10 years. These numbers give an in-use fleet average age of 15.1 years with 30.3 percent of the population with over 20 years of use (that is model year 1995 or earlier). However, the active population of highway tractors as given by the MacKay series of surveys is around 70 percent of this figure, up from 64 percent in the '90s. The average age of this active fleet is 8.5 years to be compared to the average age of a heavy-duty vehicle in the US of 9.4 years. It is to be expected that the Mexican fleet is younger because of the difference in annual growth rate. Most of the remaining 30 percent of over 20-year-old vehicles do exist, but not in normal main-line fleet operation.

The principal vocations of the active in-use fleet are "For Hire" 61 percent and "Industry & Commerce" 26 percent with almost 70 percent of these vehicles reported by fleets of over 100 vehicles. At the end of the '90s, Industry and Commerce accounted for only 11 percent of highway tractors (with a significantly higher penetration in rigid trucks). This has grown to 26 percent (in 2015) and is now dropping again with increasing usage of 3PL logistics companies to manage their transport needs.

Over the coming 24 months, "For hire" expects a net increase of 3 percent in highway tractors and 2 percent in semi-trailers whilst "Industry and Commerce" are looking at a considerable reduction in both of 33 and 22 percent respectively caused by a powerful shift towards the use of 3PL logistics companies. One main advantage of these is that they are exempt from the limitation on private fleets that have any foreign investment of transporting only those goods that are directly related to their business needs, and also have lower operating costs than "Industry and Commerce" fleets.

In the most recent survey, over half of the Highway Tractors found in the sample are Kenworth, with Freightliner in second place with 31 percent. It is interesting to note that for both brands the most recent model years showed the highest penetrations; 36 percent of all Freightliners in the sample were of 2015 or newer model year (compared the 28 percent of Kenworth)

Population of semi-trailers

The national population of registered semi-trailers at the end of 2016 is 417,000 units which has grown at an average rate of 6.6 percent per year over the last 10 years. This gives an overall ratio of semi-trailers per highway tractor that increases from 1.20 in 2005 to 1.47 in 2016. By vocation, Owner/operator have a ratio of 1.17; "For hire" transport fleets, 1.46; and Industry & Commerce 2.01. The Top 100 fleets by size (independent of vocation) give a ratio of 1.98 semi-trailers per highway tractor. As a point of reference, in the USA since 2005, the ratio of dry vans to Class 8 tractors has remained in a very tight band: 1.96 to 2.01 trailers per tractor.

Whilst fleets tend to carefully choose their tractors by make, trailers are considered more of a commodity where price is the main differencing factor. As with highway tractors, there is a difference for semi-trailers between the total number registered and those found in fleet active service. Whilst the SCT registered numbers would give an average age of 16.1 years, the active fleet has an average age of 6.9 years.
In the most recent survey 25 makes of semi-trailer were mentioned by the interviewees, of these, three makes account for almost 55 percent of the sample—Utility, Fruehauf, and Gallegos.

Vehicle population by remaining life
Highway tractors

The time that the fleet expects to keep the vehicle in operation before selling it, varies substantially by vocation. Industry and commerce expect to use their vehicles of model year 2013 or newer an additional 8 years. This life expectance drops to one year for vehicles that are 20 years old.
For "For Hire" transport fleets the story is more complex. New vehicles that are typically bought by the larger fleets have a life expectancy (with their first buyer) of less than 12 years. These (together with private fleet vehicles) are then resold to smaller fleets and resold again until they end up in the hands of owner-operators and small fleets. Because of this, after the unit has had 25 years of operation, its expected life reaches a new peak of an additional 12 years. None of the fleets in the sample had vehicles older than 1984 model year.

Semi-trailers

Industry and commerce expect to use their semi-trailers of model year 2015 or newer an additional 10 years. This life expectance drops to two years for units that are of model year 2004 or older. In the sample, Industry and commerce did not have any semi-trailers of over 20 years of age.

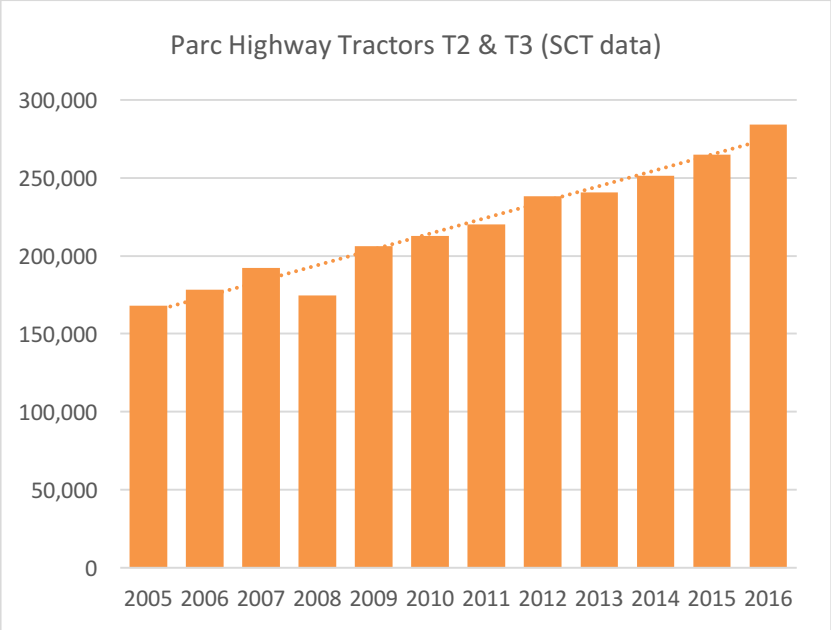
For “For Hire” transport fleets the story is more complex. New semi-trailers that are typically bought by the larger fleets and have a life expectancy (with their first buyer) of 15 years. However, as they get resold to smaller fleets their life extends considerably. Even those units in the sample of 1984 model year (33 years old) were expected by their owners to have an additional 10 years of use in them.
A large number of the interviewees, had a clear idea of the expected life of their highway tractors but when asked a similar question on semi-trailers answered, “For the life of the unit” without having a clear expectation of how long that may be.

Highway Tractors

Registered population

The most cited vehicle population figures are reported by SCT in their annual statistical report (Estadistica Básica del Autotransporte Federal).

The most recent version (2016) shows a national population of registered highway tractors (2 and 3 axle versions shown as T2 & T3) at the end of 2016 of 284,349 units which has grown at an average rate of 4.6 percent per year over the last 10 years.



Source: SCT Estadística Básica del Autotransporte Federal - 2016

Figure 13- - Registered Parc of Highway Tractors (2016) SCT data

Based on the 2016 population, 6 states account for over half of the total population (see Table 15). The complete distribution by state is shown in Figure 15.

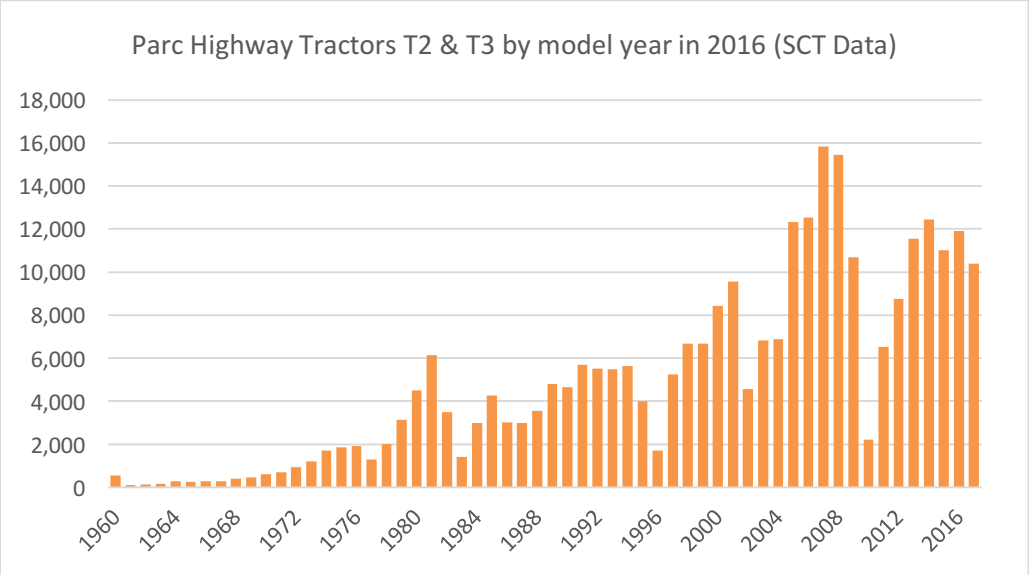
Table 15 States with most registered Highway Tractors (2016)

State	%
Ciudad de México	17%
Nuevo León	13%
Jalisco	7%
Tamaulipas	6%
Guanajuato	6%
Estado de México	5%

Source: SCT Estadística Básica del Autotransporte Federal - 2016

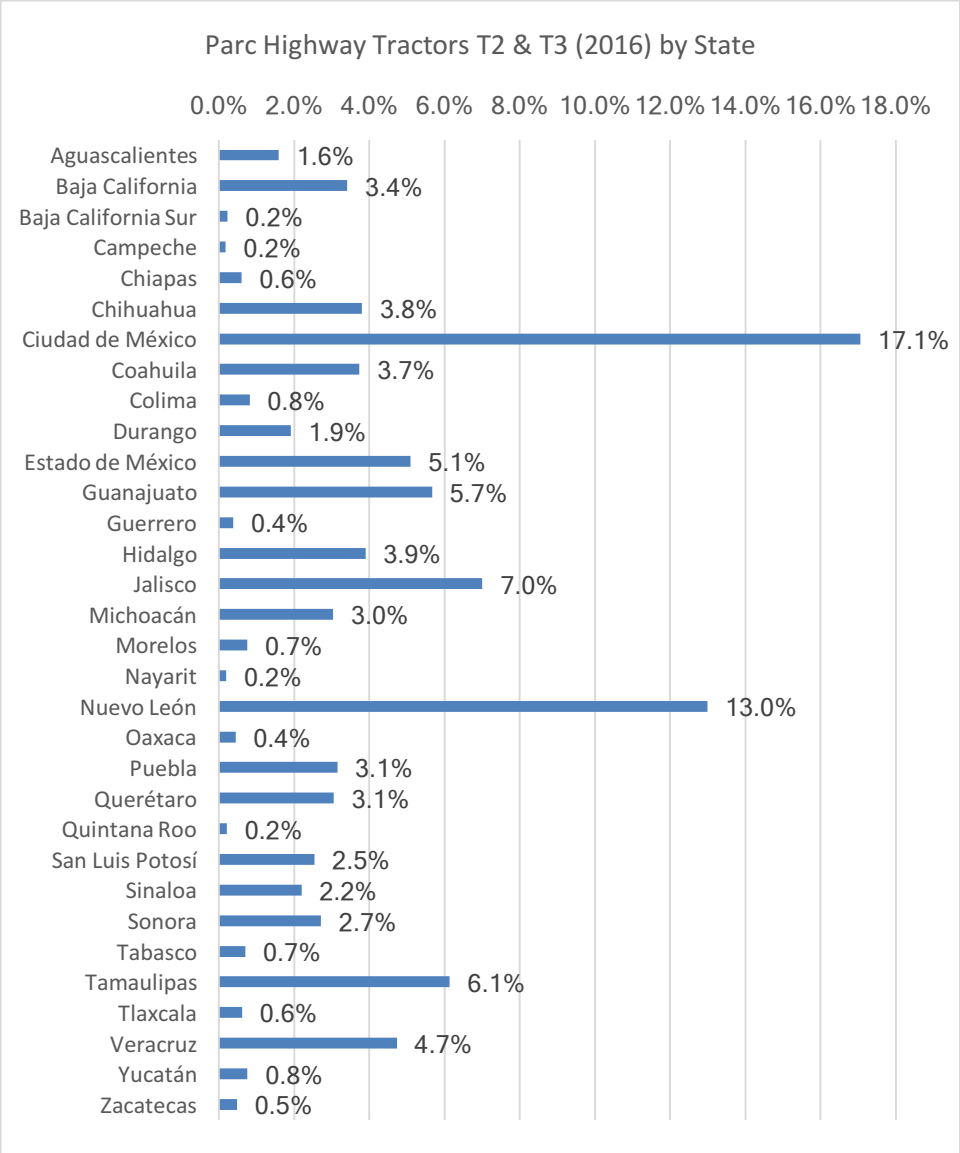
The distribution of these vehicles, in 2016, by model year is shown in Figure 14 where it can be seen how the extreme volatility of heavy duty vehicle sales (driven by economic activity) affect the in-use population.

These numbers give an in-use fleet average age of 15.1 years with 30.3 percent of the population with over 20 years of use (that is model year 1995 or earlier).



Source: SCT Estadística Básica del Autotransporte Federal - 2016

Figure 14 - Composition of the Parc of highway Tractors in 2016 by model year



Source: SCT Estadística Básica del Autotransporte Federal - 2016

Figure 15 - Population of highway Tractors (T2 & T3) by state in 2016 (SCT data)

Active population of Highway Tractors

The registered population of vehicles taken from the emission of license plates may give valid numbers for the total parc in existence, but cannot develop information on those that are really in active use. For this, other data sources are needed.

TSTES has conducted a detailed study of the heavy-duty fleet utilization (including Class 8 highway tractors and trailers) and repair practices in Mexico every four years since 1992 for Mackay & Company, Lombard, Illinois who provide it to heavy duty vehicle manufacturers and component suppliers. This series of studies is described in more detail in the annex to this report[15]. Each study has been conducted on a clean-slate, stand-alone basis and has consistently given active populations that are lower than SCT's number of registered vehicles. In the 90's for highway tractors the active fleet was around 64 percent of the registered fleet and this number has slowly increased over these 25 years to 70 percent in 2015. The population numbers have been shared with all the principal vehicle and component manufacturers and endorsed by them as being representative of the real in-use fleet and used by them to determine their replacement parts market size projections.

The most recent study was 2015. MacKay is permitting us to share the vehicle fleet data from this study with you provided that it is referenced (cited) to Mackay & Co.[16] The use of these findings is important because they represent the principal peer-reviewed study that clearly identifies the actual active in-use vehicle fleet, as compared to the license plate statistics collated by SCT of registered heavy duty vehicles.

This study gives (in 2015) an active population of highway tractors of 186,000 as compared to SCT's registration data of 265,000. The breakdown of the active population by vocation and fleet size is shown in Table 16 and the comparison between the two numbers in Table 17. Note that the fleet sizes shown are for the number of motorized Class 6, 7, and 8 goods vehicles in the fleet (rigid trucks and highway tractors). The number of trailers and semi-trailers that each fleet owns/uses is not included.

Table 16 - - Active parc of Highway Tractors in 2015 (MacKay study)

Number of Highway Tractors per Vehicle Fleet in Mexico -April, 2015

Vocation	Fleet Size					
	1–20	21–50	51–100	101–300	>300	Total
Owner/Operator	5,230	0	0	0	0	5,230
For Hire	2,084	7,039	12,882	32,190	59,579	113,775
Industry & Commerce	1,749	4,846	11,913	15,648	15,254	49,410
Construction & Mining	2,241	1,025	1,582	2,635	1,616	9,100
Agriculture	1,283	1,331	2,651	1,744	0	7,010
Government	412	1,003	95	159	72	1,741
Total	12,999	15,245	29,124	52,377	76,521	186,266

Source: Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015

[15] Together with the distribution of each sample by fleet size

[16] Please cite as Source: Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015

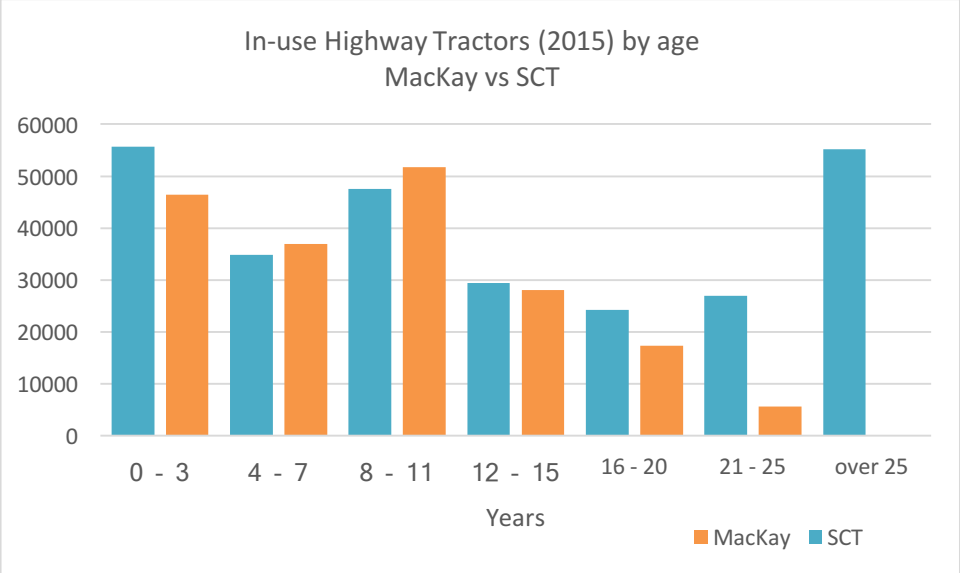
Table 17 - Comparison of registered vs in-use highway tractors in 2015

	2015	Fraction
SCT Registered Highway Tractors	264,798	
Active In-Use Highway Tractors	186,266	70.3%

When the active in-use fleet data from the MacKay study is compared to the vehicle registration data from SCT it is seen that this accounts for 70 percent of the registered fleet (see Table 17).

Figure 16 shows how these two numbers (registered vs active, in-use) compare on a model-year basis and it can be seen that the difference lies in the older vehicles. 30.8 percent of the registered highway tractors are over 20 years old (that is model year 1994 or earlier) and these are not primarily being used by fleets. The interesting exception can be seen where the MacKay numbers for vehicles between 4 and 11 years are higher than the SCT registration numbers. In this age bracket, we have an anomaly of 11,025 vehicles which are older trucks that have been completely rebuilt using imported secondhand vehicles from the USA but keeping at a minimum the original frame rails so that they can use the Mexican registration. One example was a 1953 Kenworth that to all intents and purposes was a 2007 model year unit. In our survey, the owner reported it as 2007 which was consistent to its technical specification although its registration documents showed a much older vehicle.

Highway Tractor population by age



Source: Author's analysis based on Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015 and SCT Estadística Básica del Autotransporte Federal - 2015

Figure 16 - Comparison of in-use vehicle numbers from the MacKay study (2015) vs SCT registration data

Most of the remaining 30 percent of over 20-year-old vehicles do exist, but not in normal intensive fleet operation. This population will be discussed below and has been covered by a separate survey.

Table 18 shows the distribution of this active fleet by age of vehicle. This includes the 11,000 vehicles mentioned above at the age of their technical specification. The average age of this fleet is 8.5 years. In the United States, the average age of a heavy-duty vehicle is 9.4 years. It is to be expected that the Mexican fleet is younger because of the difference in annual growth rate.

Table 18 - Population of Highway Tractors in active fleet usage

Age (yrs)	Parc	%
over 25	137	0%
21 - 25	5626	3%
16 - 20	17295	9%
12 - 15	28051	15%
8 - 11	51709	28%
4 - 7	36956	20%
0 - 3	46491	25%
Total	186266	100%

Source: Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015

Definition of the vocations

Heavy duty goods vehicles are used in two broad vocational categories that can be further subdivided:

- **For Hire** – Fleets that transport merchandize of other companies[17]
  - Owner-operator - of 1 to 5 units. Often considered as a separate category (see below).
  - Small fleets – 6 to 30 units
  - Medium fleets – 31 to 100 units
  - Large fleets – over 100 units
- **Private fleet** – Fleets that transport merchandize of the same company
  - Industry & Commerce
  - Construction & Mining
  - Agriculture
  - Government

[17] This subdivision is taken from SCT

Owner-operators

Owner-operators are those people that own and operate their own trucking business. They are free to either haul freelance (non-committal to any one firm or product), or enter into a lease agreement to dedicate their equipment to one customer or product. There are approximately 350,000 owner-operators registered in the United States and 114,308 registered for freight in Mexico[18].

In the USA, if an owner-operator operates under their own authority they will have a Department of Transportation (DOT) and Motor Carrier (MC) number identifying them as a registered carrier. However, most lease on to larger carriers and operate under that carriers DOT number. On the other hand, Professional Employee Drivers (PEDs) do not own or operate their own truck and trailer, nor do they have a DOT or MC number. Instead, they work directly for a carrier as an employee.

In the USA, owner-operators differ from PEDs in that they typically[19]:

- Are better educated (with 45 percent having college education)
- Have a higher income (net average income over $50,000 vs $38,000 to 40,000 for a PED
- Are most likely to own premium vehicles (Peterbuilt or Kenworth) often outfitted with accessories
- Are most likely to have higher powered engines (69 percent with 450 BHP or more)
- Have a substantial investment in their vehicles (with 66 percent fully paid off)
- Are away from home a 100+ nights a year with 41% spending over at least 200 nights away from home
- Typically operate full truck-load shipments

In Mexico, owner-operators also operate under their own authority. However, they typically do not have access to finance and lack this premium status.

In Mexico, owner-operators typically:

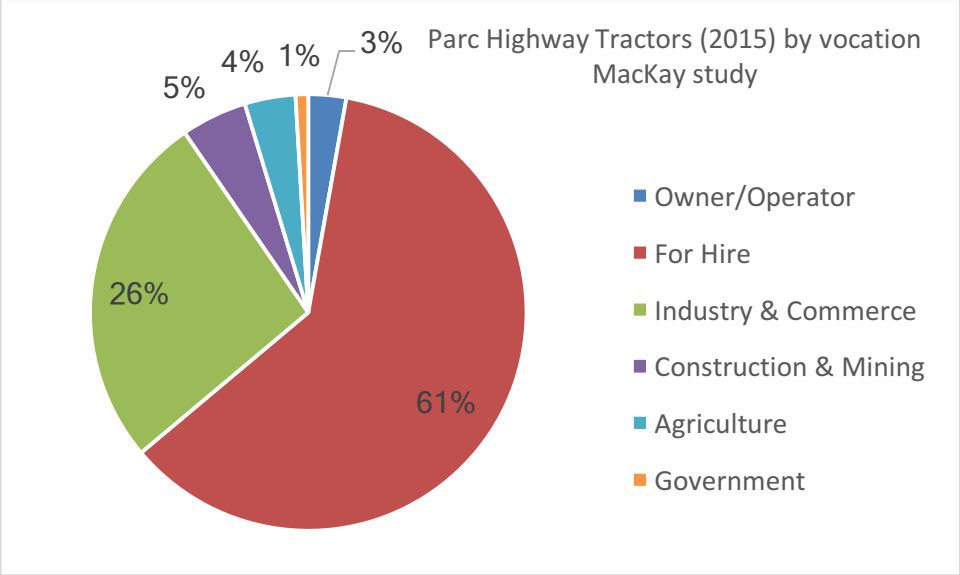
- Operate on a cash-flow basis with little or no financial planning
- Do not have a college education
- Own and use 20 year or older highway tractors and trailers which they bought second hand
- Are affiliated to other owner-operators into a loose knit fleet for commercial purposes.
- Operate on less attractive routes and feeder operations where larger fleets do not participate or compete as much.
- Often operate on less than truck load basis.
- Often operate within the informal sector.

[18] Source: SCT ESTADÍSTICA BÁSICA DEL AUTOTRANSPORTE FEDERAL 2016
[19] Source: OOIDA Foundation (see http://www.ooida.com/OOIDA%20Foundation/RecentResearch/OOfacts.asp)

Highway Tractor population by vocation

Figure 17 shows the distribution of highway tractors by vocation in 2015 from this study. Note that as opposed to the USA, the Owner-operator category is small (3 percent) which added to the For Hire category accounts for 64 percent of the in-use fleet. Industry and Commerce account for 26 percent of this total with the rest (10 percent) distributed amongst the remaining categories.

At the end of the '90s, Industry and Commerce accounted for only 11 percent of highway tractors—with a significantly higher penetration in rigid trucks.

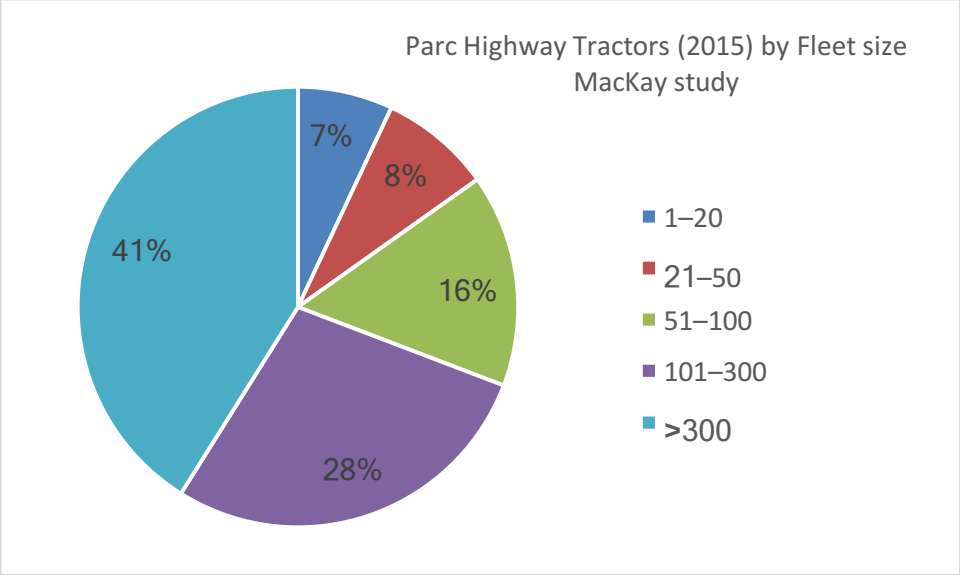


Source: Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015

Figure 17 - Parc Highway Tractors (2015) by vocation (MacKay study)

Highway Tractor population by fleet size

In Figure 18 it can be seen that almost 70 percent of the vehicles are reported by fleets of over 100 vehicles.



Source: Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015

Figure 18 - Parc Highway Tractors (2015) by fleet size (MacKay study)

Table 19 shows a table reproduced from the magazine "T21" December 2016 edition[20] giving the heavy duty vehicle population of the top 100 fleets in Mexico. They report for the "top 100" fleets the use of 33,370 highway tractors, number that compares favorably with the 76,521, reported by the MacKay study for all fleets of over 300 vehicles[21].

Table 19 - Top 100 del autotransporte T21 (10a Edición) Dec 2016

Ranking 2016	Company and State	Trailers (Semi)	Trucks	Tractors	Total Fleet
1	Grupo Transportes Monterrey (GTM) /1 N.L.	4000	39	2150	6189
2	Fondo de Transporte México (FTM) /2 Cdmx	3764	9	1554	5327
3	Grupo TUM /3 Edomex.	3129	568	1073	4770
4	Autotransportes de Carga Tresguerras Gto.	1284	622	1245	3151
5	Fletes México Chih.	2365	17	973	3355
6	Transportes Castores de Baja California Gto.	1084	1023	701	2808
7	Transportes Monroy Schiavon (TMS) Edomex.	2409	77	658	3144
8	Transportes Marva Edomex.	2040	137	653	2830

[20] Source: http://t21.com.mx/sites/default/files/archivo/Revista%20T21%20Diciembre%202016_0.pdf

[21] Note that the two datasets have slightly different dates (Dec 2016 vs April 2015) and that there are always difference in classification, in which generally speaking the MacKay study considers the fleet by centralized parts purchasing and maintenance control even though vehicles may have different owners.

Ranking 2016	Company and State	Trailers (Semi)	Trucks	Tractors	Total Fleet
9	Servicios Especializados de Transporte y Logistica (Setylsa) Coah.	1177	3	712	1892
10	Transportes Lar-Mex N.L.	1128	1	726	1855
11	Transportes Orta N.L.	867	8	683	1558
12	Transportes Internacionales Tamaulipecos Tamps.	1363	48	444	1855
13	Corporativo UNNE /4 Hgo.	1181	31	520	1732
14	Transportes Mon-Ro /5 N.L.	934	27	581	1542
15	Grupo HG Transportaciones /6 N.L.	1540		354	1894
16	Xpress Internacional Tamps.	1400		400	1800
17	Transportes Unidos Castañeda (Trucka) Ags.	1007		511	1518
18	Frío Express Ags.	758		564	1322
19	Sociedad Cooperativa de Producción y Prestación de Servicios Cuauhtémoc (Cruz Azul) Hgo.	874	5	492	1371
20	Transportes Cuauhtémoc N.L.	946	240	299	1485
21	Fletes y Materiales Forsis N.L.	870	8	420	1298
22	Super Transporte Internacional (STI) Tamps.	1175		305	1480
23	Transportistas Unidos de Morelos (TUMSA) Mor.	874	58	363	1295
24	Autotanques Nieto Qro.	781	2	411	1194
25	Grupo Valbo /7 Cdmx	198	709	139	1046
26	Trans Mex Son.			650	650
27	Grupo TLE /8 N.L.	720		348	1068
28	GranPortuaria /9 Pue.	360	308	258	763
29	Tracusa La Ruta del Sol Gto.	649	103	281	1033
30	Autotransportes El Bisonte SLP.	485	49	378	912
31	Transportes Julián de Obregón Gto.	322	292	264	878
32	Transportes Pitic Son.	422	157	326	905
33	Transportes Especializados Antonio de la Torre e Hijos Edomex.	643	2	307	952
34	Su Transporte Cdmx	608	6	304	918
35	Gonzalez Trucking Ags.	257		433	690
36	Transportes Auto Tanques Ochoa Edomex.	566	15	304	885
37	Grupo Transportes Peñón Blanco /10 N.L.	581		301	882
38	Transportes Presurizados Coah.	453	38	317	808
39	Transportes de Carga Fema Tamps.	718		219	937
40	Transportes Calvillo Tracasa Gto.	480	20	280	780
41	Flensa Gto.	507		283	790
42	Transportes Narcea Ver.	539		260	799
43	Transportes Canales Tamps.	585	15	231	831
44	TDR Transportes Qro.	338	3	318	659

Ranking 2016	Company and State	Trailers (Semi)	Trucks	Tractors	Total Fleet
45	Autotransportes Alanis Tamps.	281		339	620
46	Royal Transports Gto.	388	13	289	690
47	Transervicios Chih.	398	8	285	691
48	Corporativo Garza Ruiz /11 Tamps.	521	5	237	763
49	Logística del Mayab Yuc.	564	2	222	788
50	Transportes Mineros de Coahuila Coah.	634	2	195	831
51	Enlaces Terrestres Comerciales Jal.	438	23	250	711
52	Cemex Transporte N.L.	854	14	98	966
53	Servicios de Transportación Jaguar Edomex.	547	3	214	764
54	Express y Tanques Especializados N.L.	428	4	258	690
55	Auto Líneas Regiomontanas N.L.	292	31	288	611
56	Transportes Quintanilla Tamps.	338	1	284	623
57	Transportes Kugar del Papaloapan Ver.	531	15	196	742
58	Autotransportes Varela Dávila Tamps.	535	20	191	746
59	Express Tres Fronteras Chih.	360	3	268	631
60	rC Express n.L	524		207	731
61	Transportaciones Industriales gume Tamps.	611	1	166	778
62	Auto Express oriente Jal.	426	2	224	652
63	Transportes Elola Edomex.	194	1	312	507
64	Transportes garza Leal Coah.	396		232	628
65	Express Milac gto.	449	1	209	659
66	Servicios de Transportes CAD n.L.	287	18	254	559
67	Inter Mg Ags.	432	253	28	713
68	Transportes Bonampak Ver.	315	3	241	559
69	Movimientos Terrestres de Carga pue.	453	8	184	645
70	Auto Líneas San Antonio n.L.	384	4	208	596
71	Consorcio de Servicios Internacionales (CSI) Ver.	359	163	107	629
72	organización Sahuayo Cdmx	1	507	3	511
73	Especializados Sagot gto.	377		203	580
74	Setramex Coah.	394		195	589
75	Transportadora Integral de Carga Coah.	373	10	189	572
76	Transportadora Terrestre (Estafeta) Cdmx		495		495
77	Fletes Modernos Sago Tamps.	442		165	607
78	Transportes internacionales JCV Son.	185		260	445
79	Supertrack Chih.	306	4	206	516
80	Transportes gYM Monclova Coah.	361	4	185	550
81	Transportes Mex Ameri K Edomex.	349	4	187	540
82	Transervicios Logisticos del norte (TLn) n.L.	450		150	600
83	grupo CICE - ocupa Ver.	360		182	542

Ranking 2016	Company and State	Trailers (Semi)	Trucks	Tractors	Total Fleet
84	Trans-Energéticos n.L.	244	136	131	511
85	Super Express La Chicharra n.L.	464	2	138	604
86	Tramo del Centro SLp.	289	5	202	496
87	Transportes garcías Trucking Edomex.	254	3	216	473
88	Autotransportes del real Chih.	241	5	208	454
89	Auto Líneas Cavazos garza Hermanos n.L.	353		164	517
90	Logis Enlaces Internacionales Edomex.	360	52	123	535
91	Transportes Innovativos Jal.	250		200	450
92	Fletes y Transportes ruiz Edomex.	231	48	172	451
93	Transportes Loro Tamps.	300	14	166	480
94	Fletes Avella Edomex.	148	16	218	382
95	Transportes de C. Saltillo Monterrey Coah.	293	9	167	469
96	Auto Express nor y Caribe n.L.	337	2	151	490
97	Consolidamex Coah.	362	10	136	508
98	Impulsora de Transportes Mexicanos Sin.	269	53	140	462
99	Transportes Urgentes nuevo León n.L.	341		144	485
100	Express Sinaloa División Ensenada Edomex.	153	96	150	399
	Total	66807	6713	33730	107087

Source: T21 (10a Edición) Dec 2016 (see: http://t21.com.mx/revista-pdf)

Highway Tractor population by make

Table 20 shows the distribution of Highway Tractors by make in the sample.

Over half of the Highway Tractors found in the sample are Kenworth, with Freightliner in second place with 31 percent (see Table 20). DINA and FAMSA are all old units whilst the other makes have exhibited a growing penetration over recent years. Figure 19 shows the distribution of the 2 principal makes of Highway Tractor by model year. 36 percent of all Freightliners in the sample were of 2015 or newer model year (compared the 28 percent of Kenworth).

Table 20 - Highway Tractors by make

	number	%
Kenworth	2599	56%
Freightliner	1419	31%
International Harvester	265	6%
Volvo	252	5%
MAN	48	1%
Hino	26	1%
Famsa	9	0%
Dina	5	0%
Scania	5	0%
total	4628	

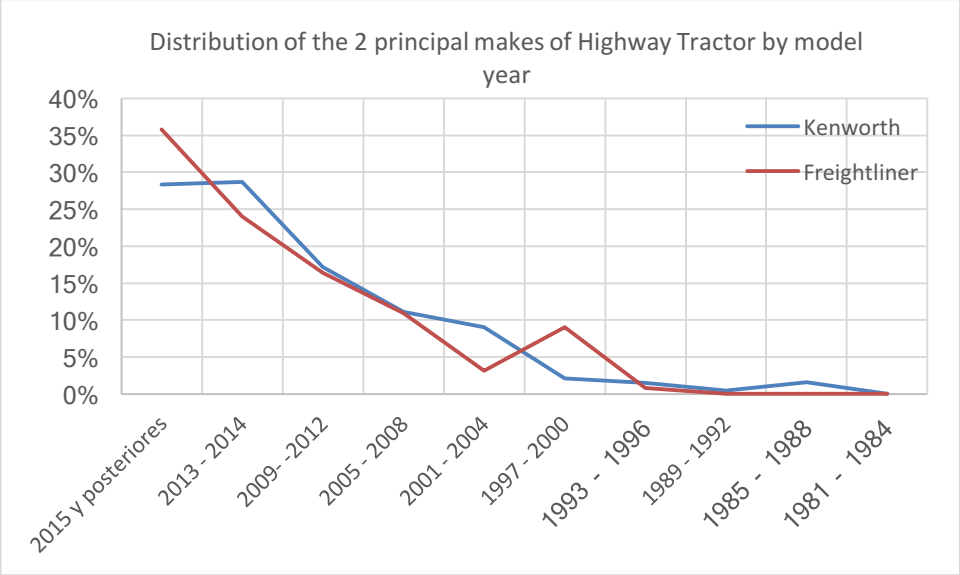


Figure 19 - Distribution of the 2 principal makes of Highway Tractor by model year

Highway tractors – engine replacement practices

Of relevance to the vehicles emissions and fuel economy is the age of the engine. Due to the extended life of heavy duty goods vehicles in Mexico, it is common practice to replace the engine, unlike the coach or lighter duty goods markets. In the sample (see Figure 20), all the Highway Tractors of 10 years or newer age, had original engines. All the Highway Tractors of over 30 years of age had non-original replacement engines, with the replacement occurring over the intervening 20 years. Around half of the

Highway Tractors of 20 years of age have replacement engines (usually of the same make as the original unit).

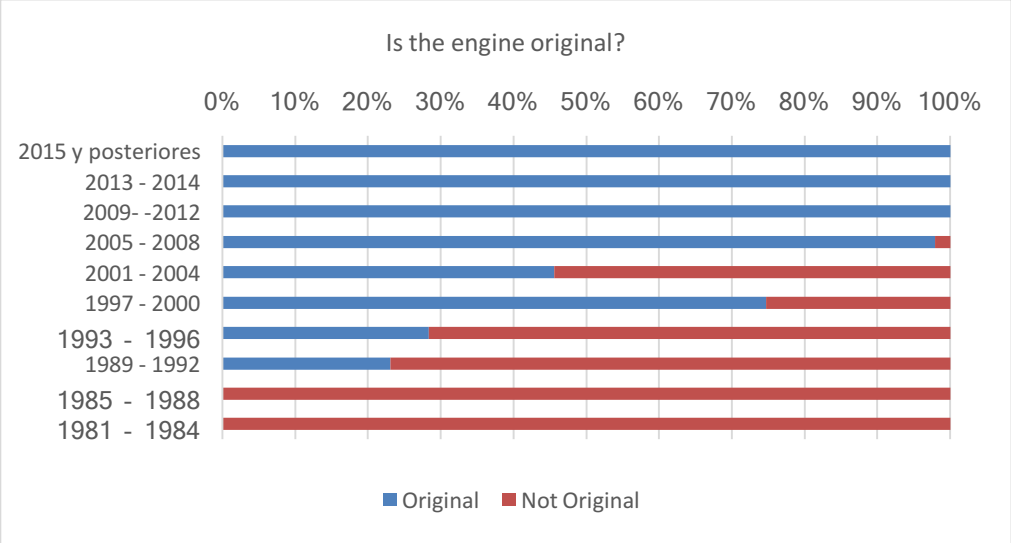


Figure 20 . A graph to show replacement of engines; is the engine original?

Highway Tractor engine population by make

67 percent of the engines in the sample were Cummins followed by Detroit Diesel with 25 percent (see Table 21).

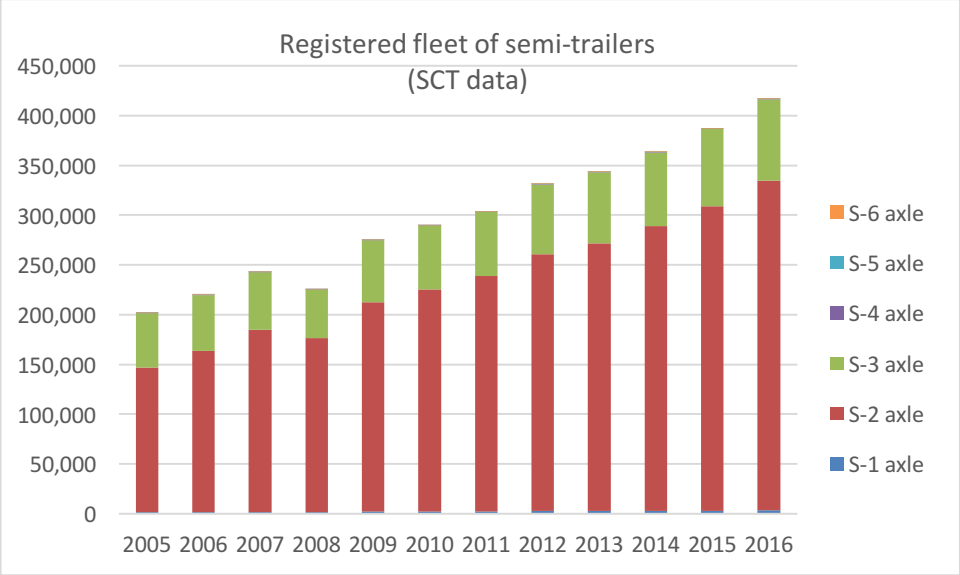
Table 21 - Engines by make

	number	%
Cummins	3,069	67%
Detroit Diesel	1,130	25%
International	3	0%
Mercedes	10	0%
Navistar	1	0%
Volvo	329	7%
Hino	26	1%
Scania	5	0%
Total	4,573	

Semi-trailers

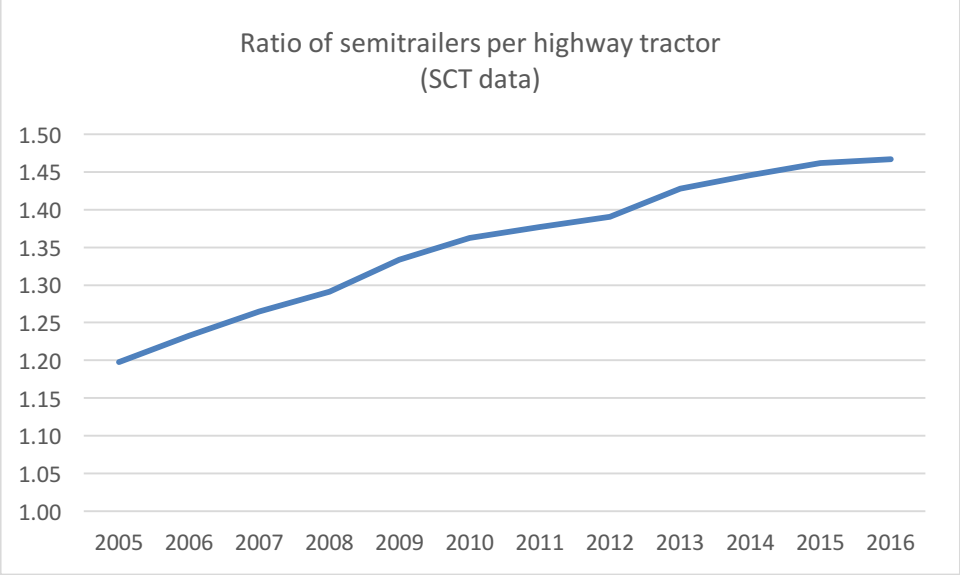
Semi-trailer population

SCT gives the population of semi-trailers in their annual statistical compendium. According to their numbers the registered in-use fleet has grown from 201,000 in 2005 to 417,000 in 2016, an average growth rate of 6.61 percent per year. This gives a ratio of semi-trailers per highway tractor that increases from 1.20 in 2005 to 1.47 in 2016 (see Figure 21).



Source: SCT Estadística Básica del Autotransporte Federal - 2016

Figure 21 - Registered fleet of semi-trailers in Mexico



Source: SCT Estadística Básica del Autotransporte Federal - 2016

Figure 22 - Ratio of Semi-trailers per highway tractor

In TSTES' MacKay (2015) and INECC (2011) studies a similar ratio was found (see Table 22), the estimation based on field surveys of 314 fleets with 13,136 highway tractors generates a ratio of 1.17 semi-trailer per owner/operator; 1.46 for "For hire" transport fleets; 2.01 for Industry & Commerce giving an overall average on 1.47 semi-trailers per highway tractor (see Table 22) whilst the T21, Top 100 fleet data gives a ratio of 1.98 semi-trailers per highway tractor which is matched (1.97) in this ICCT survey sample.

The ratio of semi-trailers per highway tractor is on average 1.97, with "Industry and Commerce" having the largest number (2.24 semi-trailers per highway tractor)—see Figure 23.

Table 22 - Ratio of semitrailers per highway tractor by vocation

	Ratio semitrailers per tractor
Owner/operator	1.17
For hire	1.46
Industry & Commerce	2.01
Overall	1.47

Source: TSTES field studies including Mackay (2015) and INECC (2011)

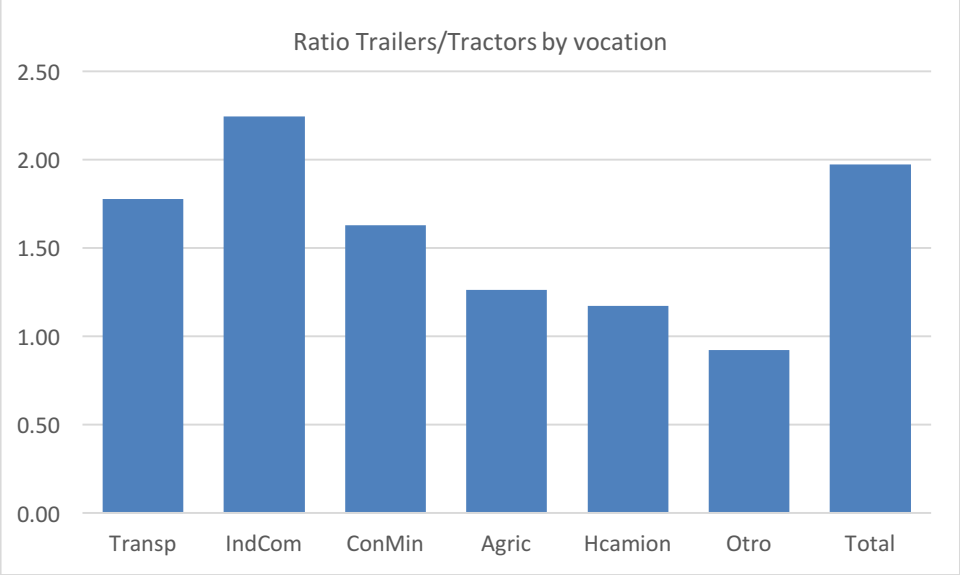


Figure 23 - Ratio Trailers/Tractors by vocation

The larger fleets tend to have more semi-trailers per tractor than the smaller fleets.

Whilst fleets tend to carefully choose their tractors by make, trailers are considered more of a commodity where price is the main differencing factor. Part of this may be because of their mechanical simplicity (interviewees regularly commented that trailers never die) but there has been a technological and regulation change that has affected those in active use over the last couple of decades. Hendrickson was established in Mexico in 1971, and became the leader in trailer suspension with their RT series. In 1990 they launched the HT air suspension for trailers and in 1995 the first integrated axle and air suspension system (INTRAAX). Today it is very rare to see trailer with RT suspension on the highway, and has taken out of active service many of the older units. Whilst the SCT registered numbers would give a parc of 387,000 semitrailers with an average age (in 2015) of 16.1 years, if we separate-out those prior to 1995 model year we end up with a parc of 267,000 with an average age of 6.9 years. Compared to the highway tractor active fleet forum in the MacKay study this gives a semi-trailer per tractor ratio of 1.44.

Semi-trailer population by type

Of the semi/trailers included in the survey, 58 percent were dry van box trailers of typically 53 ft. length. Almost 17 percent were lowboy trailers which include the specialized soft-drink double step trailers, and 14 percent the traditional flatbed trailer including a small fraction with stake body. These three body styles accounted for over 88 percent of the sample (see Table 23).

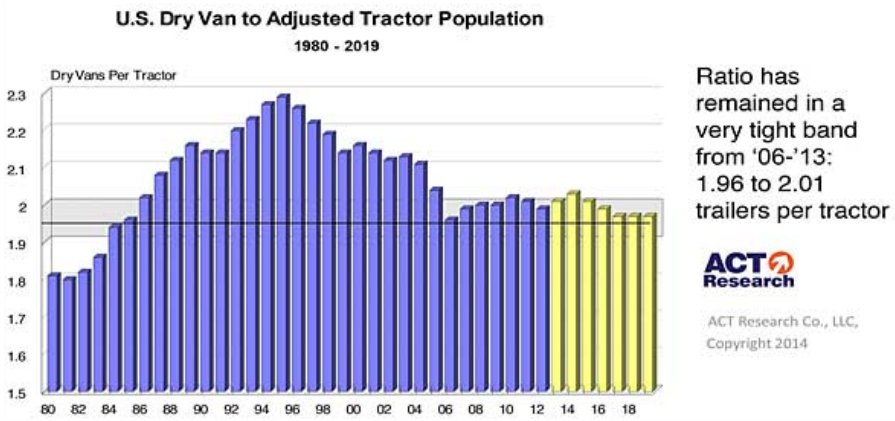
However, it is important to note that this survey, due to its limited size could be skewed. According to a 2015 study by the DGAF-SCT there are 50,000 refrigerated semi-trailers in Mexico[22], around 12 percent of the registered fleet of which 18,268 are registered to companies (“For Hire” + “Industry and Commerce”) and the remainder to private individuals. In the same way that owner-operator tractor trailers form a small share of the active fleet despite their high registered numbers, it is expected that this will also be true for refrigerated semi-trailers.

22 Source: Evolución de la flota de autotransporte refrigerado en México (2005-2015), Instituto Mexicano de Transporte

Table 23 - Semi-trailer by type

Type	Number	%
Dry Van	4977	58.0%
Lowboy	1439	16.8%
Flat Bed	1171	13.7%
Dump & Gondola	630	7.3%
Car transporter	226	2.6%
Refrigerated	67	0.8%
Stake bed	24	0.3%
Cage	24	0.3%
Tank	16	0.2%
ISOTank	2	0.0%
Container	1	0.0%
Total	8577	

As a point of reference, in the USA since 2005, the ratio of dry vans to Class 8 tractors has remained in a very tight band: 1.96 to 2.01 trailers per tractor on the dry van side (see Figure 24)[23].



Source: ACT Research http://trailer-bodybuilders.com/trailer-output/act-research-forecasts-us-trailer-shipments-grow-each-year-through-2016-then-slight-d

Figure 24 - USA ratio of dry vans to highway tractor

[23] Source: Steve Tam, vice president of Americas Commercial Transportation (ACT) Research Commercial Vehicle Sector http://trailer-bodybuilders.com/trailer-output/act-research-forecasts-us-trailer-shipments-grow-each-year-through-2016-then-slight-d

Semi-trailer population by make

25 makes of semi-trailer were mentioned by the interviewees, of these, three makes account for almost 55 percent of the sample—Utility, Fruehauf, and Gallegos. Table 24 shows the participation of each make in the sample.

Table 24 - Semi-trailer by make

Make	Number	%
Utility	1440	28.3%
Fruehauf	714	14.0%
Gallegos	629	12.4%
Bronko	601	11.8%
Stoughton	353	6.9%
Gran Danes	270	5.3%
Cottrell	232	4.6%
Hyundai	231	4.5%
Trailmobil	149	2.9%
Operbus	125	2.5%
Inland	82	1.6%
Lufkin	60	1.2%
Caitrasa	42	0.8%
Ramirez	32	0.6%
Altamirano	26	0.5%
Lozano	25	0.5%
Strick	21	0.4%
Rema	16	0.3%
Rocsa	11	0.2%
RyV	8	0.2%
Troy	8	0.2%
Magar	7	0.1%
Karma	4	0.1%
Igsa	2	0.0%
Pratt	2	0.0%
Total	5090	

Age and expected life of vehicles

According to SCT's registration records, the average age of registered highway tractors is 15.1 years with 30.3 percent of the population with over 20 years of age (that is model year 1995 or earlier). However, this sample of ***active*** in-use vehicles tells a different story. The average age of highway tractors in the

sample is 5.8 years, whilst that of semi-trailers is 8.4 years (see Figure 25). Of the three vocations most represented in the sample, “Construction and mining” has the youngest fleet of highway tractors and semi-trailers (2.5 and 4.6 years respectively). “For Hire” has an average age for highway tractors that is lower than “Industry and Commerce” (5.8 and 6.2 years respectively) but their semi-trailer fleet is older (9.2 and 8.2 years respectively). These numbers have been repeatedly peer-reviewed by the major vehicle manufacturers and align with their experience and other studies.

Average age of vehicles by vocation

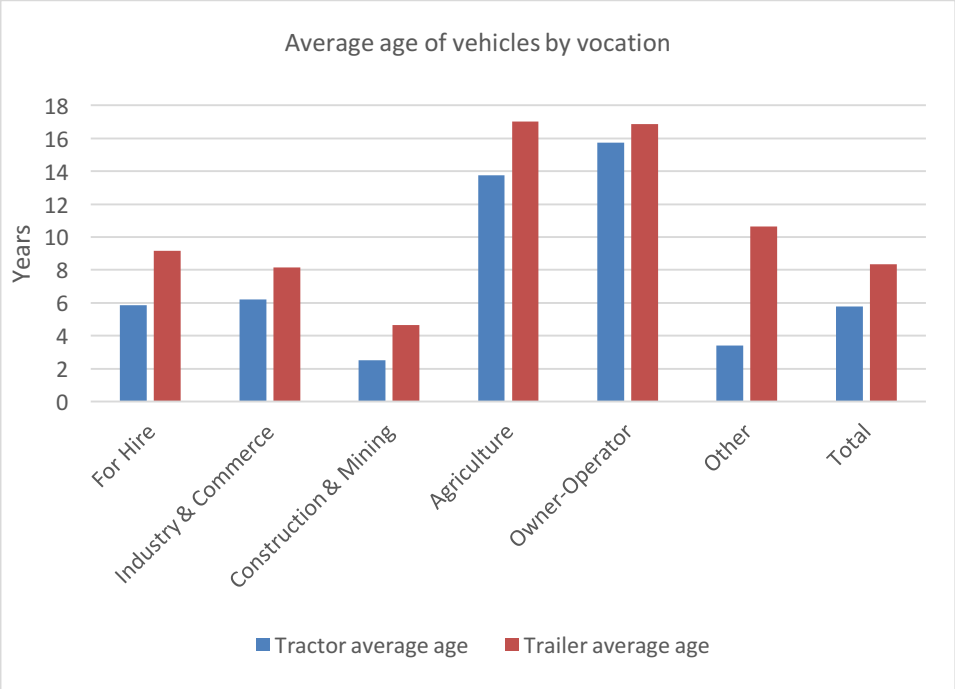


Figure 25 - Average age of vehicles by vocation

Highway Tractor population by remaining life

The time that the fleet expects to keep the vehicle in operation before selling it, varies substantially by vocation. Figure 26 shows how Industry and commerce expect to use their vehicles of model year 2013 or newer an additional 8 years. This life expectance drops to one year for vehicles that are 20 years old.

For “For Hire” transport fleets the story is more complex. New vehicles that are typically bought by the larger fleets have a life expectancy (with their first buyer) of less than 12 years. These (together with private fleet vehicles) are then resold to smaller fleets and resold again until they end up in the hands of owner-operators and small fleets. Because of this, after the unit has had 25 years of operation, its expected life reaches a new peak of an additional 12 years. None of the fleets in the sample had vehicles older than 1984 model year (33 years).

There is a clear differentiation between the larger fleets that operate within the formal sector, buy new or recent-model trucks and set freight price parameters, and the small fleets and owner/operators that often operate in a more informal environment. According to Carlos Gil Jiménez, sub-director of the Dirección General del Autotransporte Federal SCT, these are forced towards the informal purchase of old trucks from acquaintances instead of benefiting from scrappage or other government financing, because they are not credit worthy, operate mainly on a cash flow basis and avoid the additional expense of operating in a more formal structure. As long as the authorities exert limited—or negligible--control on these operators, he and CONATRAM expect disorder to continue in this sector of the market that involves an excessive number of old, low usage, vehicles.

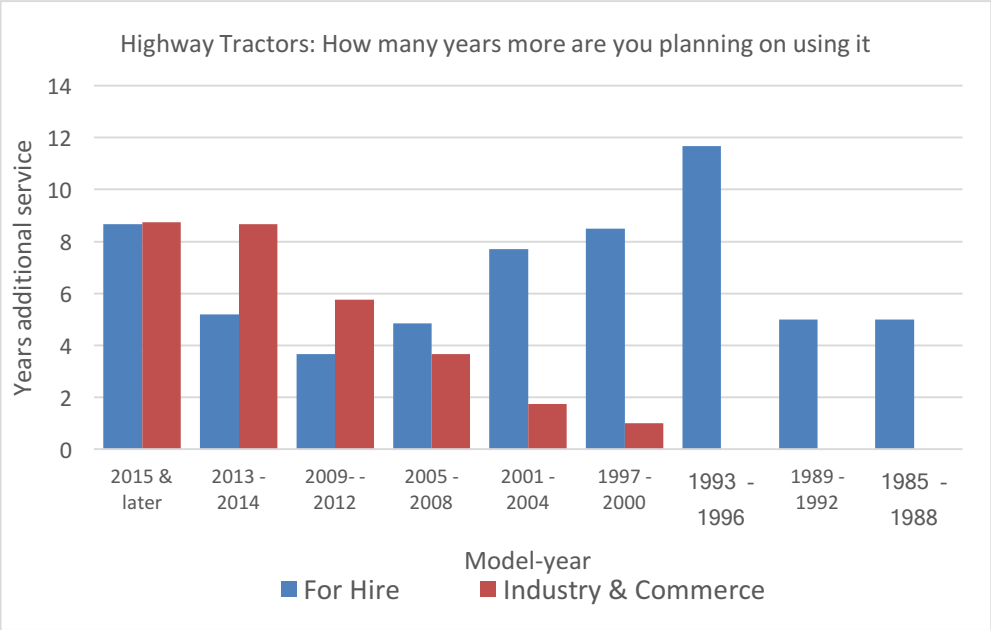


Figure 26 - How many years more are you planning on using your highway tractor?

Semi-trailer population by remaining life

Figure 27 shows how Industry and commerce expect to use their semi-trailers of model year 2015 or newer an additional 10 years. This life expectance drops to two years for units that are of model year 2004 or older. In the sample, Industry and commerce did not have any semi-trailers of over 20 years of age.

For “For Hire” transport fleets the story is more complex. New semi-trailers that are typically bought by the larger fleets and have a life expectancy (with their first buyer) of 15 years. However, as they get resold to smaller fleets their life extends considerably. Even those units in the sample of 1984 model year (33 years old) were expected by their owners to have an additional 10 years of use in them.

A large number of the interviewees, had a clear idea of the expected life of their highway tractors but when asked a similar question on semi-trailers answered "for the life of the unit" without having a clear expectation of how long that may be.

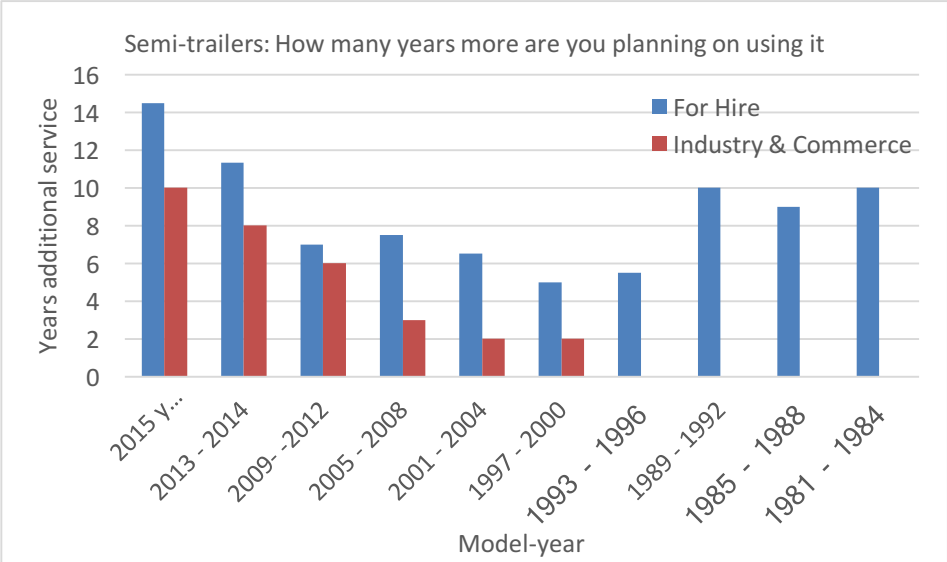


Figure 27 - Semi-trailers: How many years more are you planning on using it?

Highway Tractor Technology

On a different theme, the survey asked about the number of vehicles that (i) had electronic fuel injection; and (ii) were compliant with EPA2004 regulations to be able to enter the USA[24]. Here the interviewees stated that over 98 percent of all the highway tractors had electronic injection except for the "For Hire" vocation (82 percent) and agriculture (89 percent). Similarly, over 95 percent of "Industry & Commerce" and "Construction & Mining" vocations met the requirements of the EPA to operate in the USA, whilst only 50 percent of "For Hire", "Agriculture", and "Owner-operator" vocations met this technological level (see Figure 28). It is important to note that California requires Mexican trucks to be EPA 2010 compliant.

[24] The 1994 North American Free Trade Act (NAFTA) contained a provision that called for Mexican trucks to be allowed to travel beyond the 6 – 25 mile wide "commercial zone" in the US by December 1995. This was hotly opposed by the Teamsters Union and finally came into force in October 2011. The agreement requires the Mexican trucks to meet at least EPA 2004 emissions standards amongst other requirements. The agreement also gives US trucking companies access to Mexican highways, but few take advantage of this because transport costs with Mexican haulers is much cheaper. It does not change much for Mexican trucking companies either because a different law prohibits them carrying goods between US destinations, so if they do not have a return delivery the trucks come back empty.

The Vehicle OEMs have resisted promoting in Mexico, heavy-duty vehicles that meet current EPA emissions regulations until the diesel specifications (ultra-low sulfur) in the whole country are consistent with the USA.

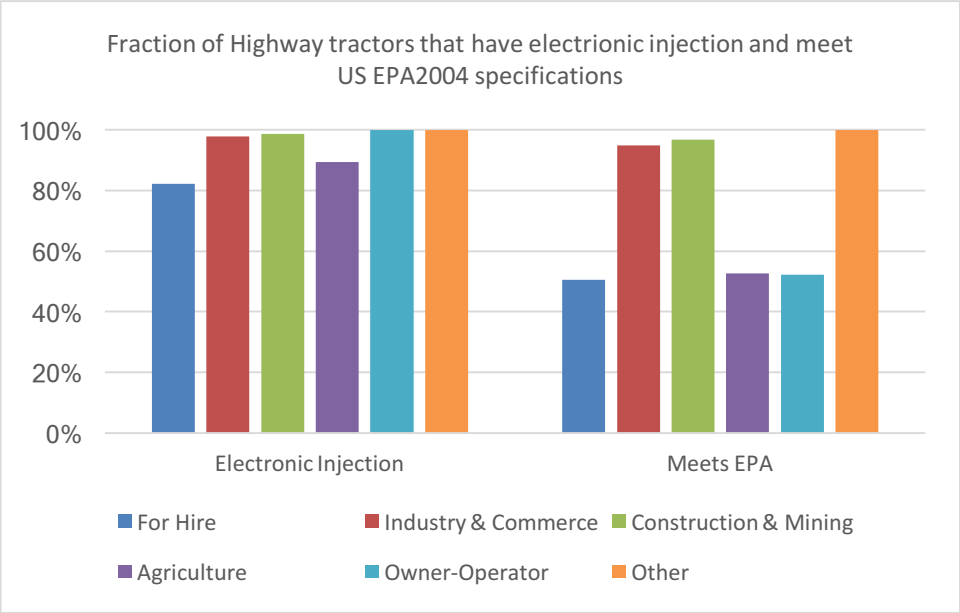


Figure 28 - Technological level of highway tractors

Several fleets commented on taking advantage of the vehicle's technology. They parameterize three points:

1) Speed: Saying that they do not require speed, only torque. A top speed of 70 kilometers per hour is more than enough for many fleets which helps them to save fuel.
2) The automatic engine stop set at three minutes. That logically helps greatly decrease the fuel consumption.
3) Another function that current electronic engines allow, is to reduce and limit the maximum engine speed in idle. One of the bad practices that operators have is to start the truck and immediately accelerate it to warm up faster. That leads to revolutions per minute of 2,500 rpm, for example. Many fleets take advantage of the technology and are programmed in such a way that the maximum revolutions, when the truck is stationary, are at 1,500 or 1,700 rpm. That also helps to control consumption.

Many of the larger fleets reported having analyzed different technologies. However, often there is not enough information to make a decision on investing in a particular feature. For example: tires. The fleets “know” that there are tires that help reduce fuel consumption, but no one can tell them how much benefit they will give under each fleet’s style of operation. This requires each fleet to invest in tests, evaluations, and build a business case analysis. Those that do this, do not follow any known test

protocol, and without anything established, do not produce results that would help another fleet base their decisions.

According to the interviewees, one benefit of having the "Transporte Limpio" Program, is that it pushes them to be constantly measuring, and thinking about future improvements. However, the program could do a lot more in helping fleets obtain information to base their investment decisions on, without having to do individual testing.

In the USA, the Technology & Maintenance Council of American Trucking Associations (TMC) provides access to quality data on expected efficiency improvements and the costs associated with obtaining them by establishing test protocols[25] and helping generate that information, and participating in forums where this information is shared. In many cases a single product can be available from a number of different suppliers (such as trailer aerodynamic treatments) and this TMC testing is particularly useful in these cases.

It would be very useful for Transporte Limpio to provide as part of the program some kind of calculator, that helps fleets with determining the return on investment for these technologies. Most fleets are really looking for payback of 18 or 24 months.

The theme of biodiesel is also important and is something the fleets know little about. They know that engine manufacturers only allow you to mix 95 percent diesel and 5 percent bio, but believe that there could be big benefits of going to higher mixes.

Tires

The interviewees were questioned about the make of tire that they use. The most popular brand is Michelin (X one & Duals) with 26 percent followed by Bridgestone (Ecopia) with 19 percent and in third place those that do not specify a particular make of tire (14 percent) – see Table 25.

The preferences for Michelin and Bridgestone are based on durability, prestige, and fuel economy giving the lowest cost per km (according to those that use each). Those that do not specify a brand or make, look for lowest cost often specifying new radial tires for the highway tractor and retreaded units for the semi-trailer. The users of Firestone highlight that they can be easily retreaded, whilst the users of Goodyear focus on their durability. The owners that choose Chinese tires do so specifically because of their low initial cost.

[25] As an example of this, the Joint TMC/SAE Fuel Consumption Test Procedure-Type II (J1321_201202) provides a standardized test procedure for comparing the in-service fuel consumption of two conditions of a test vehicle that is especially suitable for testing the efficiency gain from components in fleet vehicles of over 10,000 lbs. GVW operating over representative routes.

Table 25 – Make of Tire used

Make of tire	%
Michellín (X one & Duals)	26%
Bridgestone (Ecopia)	19%
Goodyear	7%
Firestone	7%
China	7%
BF Goodrich	5%
Yokohama	2%
Sumitomo Tire	2%
Dominator Tires	2%
Continental	2%
Triangle Tire	2%
Dayton Truck Tires	2%
No specific make	14%

According to the transport fleets interviewed, a Michelin tire costs around, MN$5000, giving a life of 150 thousand kilometers. Bridgestone costs MN$4000, but gives a life of only 130 thousand kilometers.

The Michelin super single wide base single drive tire gives good fuel economy but is not allowed for dangerous cargos. It has an issue of replacement and service is complicated: it is not easy to find a person who knows how to repair that tire because it carries another specification of patch repairs and consumables. Both Michelin and Bridgestone have super singles here in Mexico. In the case of Michelin, it has established route based service support from Mexico City to Nuevo Laredo and Michelin provides an 0800 telephone number for fleets to call and a service guarantee. Mexico to Tijuana is the other corridor they are developing.

Usage of Air Conditioning

One of the questions asked in the 2011 field survey of fleets pertained to the use of air conditioning in their units because of its impact on fuel economy. The study discovered that 75 percent of highway tractors had AC fitted to their cabs (see Table 26), with the percentage highest in private fleets that transport their own goods such as Industry & Commerce (98 percent) and Agriculture (92 percent) with the For Hire fleet running more than 20 percentage points behind (72 percent) and almost non-existent in the Owner-operator units.

As far as reefer semi-trailers are concerned in 2011, only 16 out of 2,855 vehicles in the sample typically hauled reefer-equipped trailers.

Table 26 - Usage of Air Conditioning

Highway Tractors	Owner-Operator	For Hire	Industry & Commerce	Construction & Mining	Agriculture	Government	Total
Total Vehicles	6	2,353	344	107	13	32	2,855
With Air Conditioning	1	1,687	336	70	12	26	2,132
With Reefer semitrailer	0	4	11	0	1	0	16
Percent							
With Air Conditioning	16.7%	71.7%	97.7%	65.4%	92.3%	81.3%	74.6%
With Reefer semitrailer	0.0%	0.2%	3.2%	0.0%	7.7%	0.0%	0.6%

Source: TSTES field study for INECC (2011)

Chapter 4:- Vehicle Purchasing

This chapter compiles information on how fleets buy highway tractors and semi-trailers. It looks at the sources of information, advertising, and publicity that is used to promote second-hand vehicle sales, how purchases are financed, and the motives for selecting a specific brand.

Chapter Highlights

Source of information and publicity
The OEM dealer is still the predominant source of information on second-hand highway tractors and semi-trailers. For the former, their influence as a source of information on available second-hand vehicleshas increased substantially over the last 5 years (from 21 to 50 percent) and for the latter, it has increased from 18 to 48 percent.
In both markets, buying from a known fleet keeps its 2nd spot in importance accounting for around 23 percent of purchases in both markets and over both periods.
The largest transport fleets tend to buy new vehicles on 36 to 48-month commercial credit and often sell these vehicles after 4 – 5 years. They are then sold, normally by the fleets themselves, and occasionally by OEM dealers, to the next level of fleet. Very limited advertising accompanies these sales as buyers and sellers are usually known to each other through previous operations.
Publicity starts to pay a role in the next level of sale when the highway tractor has around 6-8 years of use. These vehicles start appearing in on-line adverts, usually promoted by their owner.

Motives for choosing a specific make of highway tractor
Interviewees were asked to rate a list of reasons for choosing the make of highway tractor that they ended up buying. 73 percent of interviewees rated “Familiarity with the Brand” as having the highest importance closely followed by price (64 - 66 percent) considering “Price and availability of spare parts” and “Price of the Unit” respectively.
43 percent of the interviewees also considered “Fuel Economy” important. 36 to 37 percent also graded “Durability of the unit in our routes”, and “Power / Handling”. Interestingly the preference of the different areas of the fleet received very low scores.

Motives for choosing a specific make of semi-trailer
For semi-trailers, the overwhelming reason for selecting a specific unit is price (52 percent of interviewees) followed by “Familiarity with the Brand” (50 percent) and “Durability in our routes” (43 percent). “Price and availability of spare parts” came in fourth place with 25 percent of the sample.

How purchases are financed

The predominant means of buying a highway tractor or semi-trailer is through the application of the fleet's own resources (equity). Around 70 percent of units are purchased in this way, due to the difficulty of accessing financing. However, over the last five years this situation has changed slightly with financing through OEMs playing a larger part, increasing from 9 percent to 15 percent for highway tractors—to become the second most important source after equity-- and from 6 to 9 percent for semi-trailers.

For semi-trailers the second most important source is leasing, which has increased from 6 to 17 percent over the last 5 years, whereas highway tractors leasing went form 6 to 12 percent in the same period.

Bank credit was an option only for Industry, Commerce and Agricultural companies that have good credit ratings. Transport fleets do not have this option and are more dependent on the commercial credit offered by the company selling the vehicle.

Owner/operators purchase over 80 percent of their vehicles using their own resources, because they do not have any alternative. They typically have older vehicles with low annual mileages, low load factors, and very limited access to finance, which makes it very difficult for them, as a group to progress.

Current problems with financing

Interviewees cited high interest rate as the principal problem for private loans. Leasing, despite being expensive has increased its participation, particularly for semi-trailers, whilst OEM financing is becoming the predominant source of external funding for highway tractors. The main problems associated with getting OEM financing for new vehicles are; high interest rates, difficulty in proving adequate income, loan period too short and the vehicle not always being considered as collateral for the loan.

Choice of Engine Technology

Over 98 percent of all the highway tractors in the most recent survey had electronic injection except for the "For Hire" vocation (82 percent) and agriculture (89 percent). Similarly, over 95 percent of "Industry & Commerce" and "Construction & Mining" vocations met the requirements of the EPA2004 to operate in the USA, whilst only 50 percent of other vocations met this technological level.

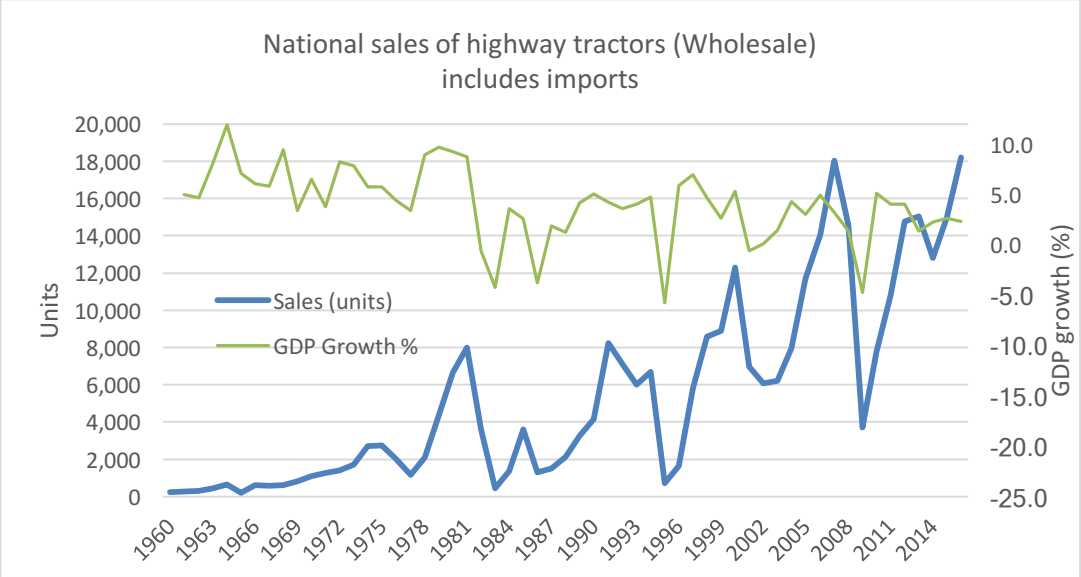
In the 2011 survey we found that 75 percent of highway tractors had AC fitted to their cabs with the percentage highest in private fleets that transport their own goods such as Industry & Commerce (98 percent) and Agriculture (92 percent). In contrast, for-hire fleets are more than 20 percentage points behind (72 percent) and almost non-existent in the owner-operator units.

Importance of Replacement practices

Engine's age is a critica element forvehicles' emissions and fuel economy performance. All the highway tractors of 10 years or less, had original engines. All the highway tractors of over 30 years of age had non-original replaced engines, with the replacement occurring over the intervening 20 years.

New Vehicle sales

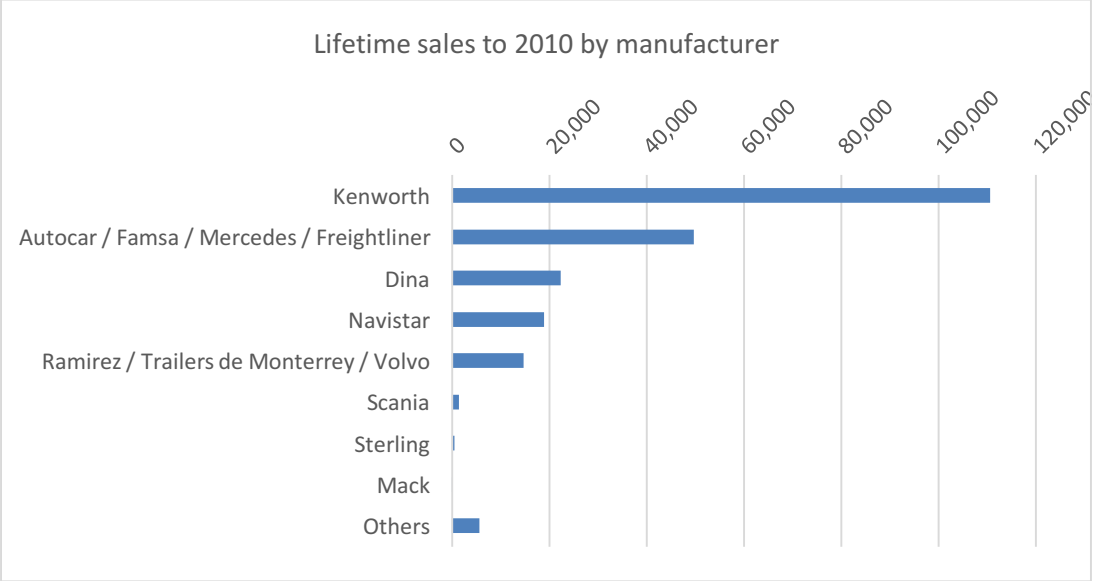
Heavy duty vehicle sales in Mexico, and particularly highway tractors, have always been very reactive to any changes in the economy. Each economic cycle is clearly marked in Figure 29 which shows unit wholesale sales (in units) and national GDP growth (as percent). Sales to distributors in 2016 reached record levels (18,225) surpassing the previous high in 2007, before the USA recession.



Source: TSTES records from AMIA, ANPACT, INEGI and other data

Figure 29 - National sales of highway tractors (Wholesale)

On a lifetime sales basis, from 1963 to 2010, 48 percent of all highway tractors sold in Mexico have been Kenworth (see Figure 30). In second place the combination of Autocar, Famsa, Mercedes, and Freightliner comes in with 21 percent, followed by Dina with 10 percent.

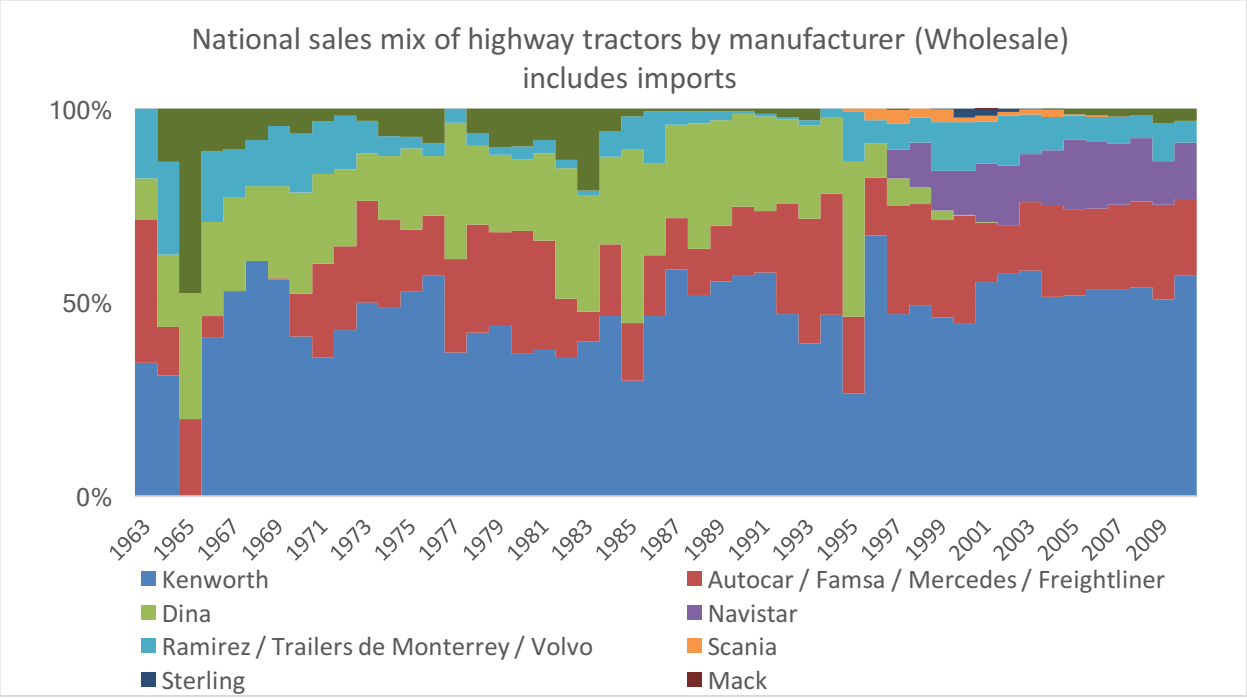


Source: AMIA, ANPACT, INEGI

Figure 30 – Total national sales of highway tractors by manufacturer 1963 - 2010

The most recent year with published sales data by manufacturer (2010) shows that Kenworth has maintained its lead accounting in 2010 for 57 percent of national sales to dealers (see Figure 31). Freightliner in 2010 is in second place with 20 percent and Navistar in third with 15 percent of sales[26].

[26] Note that Navistar entered the Mexican market in 1998



Source: ANPACT

Figure 31 - 2010 National sales of highway tractors by manufacturer

Purchase patterns of vehicles

A series of questions related to how units are bought, starting with how fleets locate the units that they wish to buy, and how this has changed over the last 5 years.

The OEM dealer is still the predominant source of information on second-hand highway tractors and semi-trailers. For the former, their influence as a source of information has increased substantially over the last 5 years from 21 to 50 percent and for the latter, it has increased from 18 to 48 percent.

In both markets, "buying from a known fleet" keeps its 2nd spot in importance accounting for around 23 percent of purchases in both markets, today and 5-years ago.

According to the fleets interviewed, Kenworth continues to be the market leader but Volvo is fighting to increase participation by lending highway tractors to fleets with no payment. The fleets are getting a positive experience with Volvo, which they say has good performance. However, Volvo is considered to be more delicate from a maintenance point of view; its parts are not so easily found and are more expensive--but not as expensive as Mercedes Benz. The fleets reiterated that one big advantage of Kenworth is that its parts are cheaper, and can be easily found anywhere in the country.

Most Freightliner customers have credit agreements and are acquiring highway tractors through pure or fiscal lease agreements in which the manufacturer is responsible for keeping the unit in good condition. Other purchasers make use of the traditional credit system. Of these, the larger companies tend to request technical and maintenance training from the manufacturer, as part of the agreement of collaboration in the acquisition of the units.

The interviewees agreed this sector needs access to flexible loans, with clear operating rules that are routinely complied with. In addition, they stressed the importance of allowing the vehicle as guarantee for the payment of the unit.

Owner-operators require additional help. Currently they own mainly vehicles from 20 to more than 30 years of age and typically operate with very low annual mileage (on average, a quarter of the expected usage of a new unit in large fleet) and a low utilization rate, so it is impossible for them to buy new units. They can only afford to buy older units, which are not subject to credit and are intrinsically more expensive to operate, which further reduces their possible operating profit, limiting fleet renewal even further.

Several actions would be required to reverse this trend; the availability of a soft credit system could allow owner-operators to leave behind their oldest vehicles, and be enticed to become more efficient organizations that can easily comply with laws and regulations. In addition, it would be important to fix a maximum age for in-use heavy duty vehicles that encourages fleet renewal and removes from circulation those obsolete and unsafe units.

Used Vehicle sales

As discussed previously, the largest transport fleets tend to buy new vehicles on 36 to 48 month commercial credit and often sell these vehicles after 4 or 5 years. Over this period the vehicle is mainly covered by warranty, and has very limited maintenance costs or downtime. Then they are sold, normally by the fleets themselves, and occasionally by OEM dealers, to the next level of fleet. Sale advertising is very limited, as buyers and sellers are usually known each other through previous operations. Some fleets advertise their vehicles for sale on their Facebook pages (for example Paqueteria Castores).

Several large fleets commented that they have agents who know that every year the fleet will getting rid of around 30 to 40 highway tractors and setup auctions for them. These agents are given a percentage of the sale of each truck that is sold.

How are vehicles for sale located

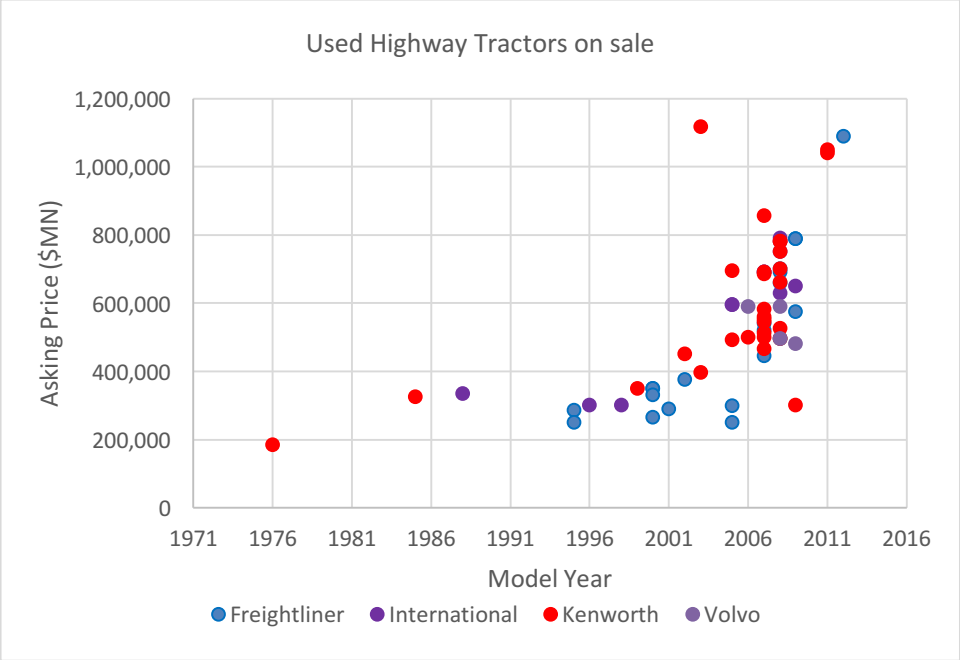
Publicity starts to pay a role in the next level of sale when the highway tractor has around 6 to 8 years of use. These vehicles start appearing in on-line adverts, usually promoted by their owner. Five popular

sites advertising secondhand highway tractors are illustrated in Table 27. Figure 32 shows the distribution of advertised secondhand highway tractors on one of these sites by make, model year and asking price.

Table 27 - Popular sites for used highway tractors

Site	highway tractors on sale
https://www.vivanuncios.com.mx	Over 700
https://www.seminuevos.com	Over 200
http://www.todoclasificados.mx/	Over 200
http://www.segundamano.mx	Over 160
http://vehiculos.mercadolibre.com.mx	Over 80

Source: TSTES investigation on March 14, 2017



Source: 3/14/2017 http://vehiculos.mercadolibre.com.mx/camiones/tractocamion

Figure 32 - Used Highway Tractors on sale by model year

Mercado Libre (http://www.mercadolibre.com.mx/) has diminished considerably in importance. For the fleets in the survey, 5 years ago this site was used to locate 15 percent of highway tractors and semi-trailers contrasting with todays 12 percent and 8 percent respectively. Its nearest competitor Vivanuncios (www.vivanuncios.com.mx) has, according to this limited sample, only 4 percent of referrals today, slightly up from 3 percent, 5 years ago.

It is interesting to note that recommendations of acquaintances used to be important in this decision five years ago (with 21 and 23 percent for highway tractors and semi-trailers respectively) but today

accounts for around 4 percent. Similarly adverts in magazines and newspapers and the classified section have dropped in importance from over 15 percent to under 4 percent for semi-trailers and zero for highway tractors in five years with the rise in the use of electronic media (see Table 28).

Table 28 - How do you find the unit to be able to buy it?

	Highway Tractors		Semi-trailers	
Medio	Now	5 years ago	Now	5 years ago
Percent responses	%	%	%	%
OEM Dealer	50.0%	20.5%	48.0%	17.9%
Through a known fleet	23.1%	23.1%	24.0%	23.1%
Mercado Libre	11.5%	15.4%	8.0%	15.4%
Vivanuncios	3.8%	2.6%	4.0%	2.6%
Segunda mano	3.8%	2.6%	4.0%	2.6%
Through a known person	3.8%	20.5%	4.0%	23.1%
Sales lot in Mexico	3.8%	0.0%	4.0%	0.0%
Todos clasificados	0.0%	5.1%	4.0%	5.1%
Advert in Magazine/Paper	0.0%	10.3%	0.0%	10.3%
Sales lot in USA or border	0.0%	0.0%	0.0%	0.0%
Other	0.0%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%

Expected sales price for used units

Table 29 shows the responses of the interviewed companies on their expected sales price for units that they put into the second-hand market. It can be seen, by comparison with Figure 32 that these are pretty-much in-line with the advertised market values[27].

[27] with some differences caused by additional equipment and/or individual negociation strategies

Table 29 - Expected second-hand resale price

	Highway Tractors		Semi-trailers	
Condition	Excellent	Good	Excellent	Good
2015 y posteriores				
2013 - 2014	900,000	741,667		
2009- -2012	800,000	490,452		
2005 - 2008		266,667		79,110
2001 - 2004	600,000	325,000		76,271
1997 - 2000		100,000		45,842
1993 - 1996				19,667
1989 - 1992		300,000		39,400
1985 - 1988				33,000
1981 - 1984		234,000		
1977 - 1980				

Motives for choosing a specific make of highway tractor

Interviewees were asked to rate a list of reasons for choosing the make of highway tractor that they ended up buying on a scale of 0 to 5 where 5 is the highest importance and 0 no importance at all.

Amongst the 44 fleets sampled, 77 percent of interviewees rated "Familiarity with the Brand" as having the highest importance closely followed by price (68 percent) considering "Price and availability of spare parts" and "Price of the Unit".

48 percent of the interviewees also considered important "Fuel Economy". 46 percent also graded "Durability of the unit in our routes", and "Power / Handling". Interestingly the preference of the different areas of the fleet received low scores: Operators 25 percent, Manager or Owners 23 percent, and workshop / service manager only 5 percent[28].

[28] Negative differences imply that more fleets considered the item as unimportant tan those that considered it important

Table 30 – Reasons for choosing this make of Highway Tractor

	Important	Neutral	Unimportant
Rating	4 or 5	3	0, 1, or 2
Familiarity with the Brand	77.3%	18.2%	4.5%
Price and availability of spare parts	68.2%	27.3%	4.5%
Price of the Unit	68.2%	29.5%	2.3%
Fuel economy	47.7%	47.7%	4.5%
Durability in our routes	45.5%	45.5%	9.1%
Power / Handling	45.5%	47.7%	6.8%
Preference of the operators	25.0%	68.2%	6.8%
Peference of the fleet (Manager or Owners)	22.7%	77.3%	0.0%
Availability of credit	18.2%	70.5%	11.4%
To retain good operators	9.1%	81.8%	9.1%
Contractual Obligations of the Company	6.8%	81.8%	11.4%
Preference of the workshop / service manager	4.5%	84.1%	11.4%

Motives for choosing a specific make of semi-trailer

For semi-trailers, amongst the 44 fleets interviewed, the overwhelming reason for selecting a specific unit is price (57 percent of interviewees) followed by “Familiarity with the Brand” (50 percent) and Durability in our routes (46 percent). “Price and availability of spare parts” came in fourth place with 32 percent of the sample. All other reasons, including preferences of operators, owners and service managers received little importance (see Table 31).

Table 31 - Reasons for choosing this make of Semi-trailer

	Important	Neutral	Unimportant
Rating	4 or 5	3%	0, 1, or 2
Unit Price	56.8%	38.6%	4.5%
Familiarity with the Brand	50.0%	47.7%	2.3%
Durability in our routes	45.5%	52.3%	2.3%
Price and availability of spare parts	31.8%	61.4%	6.8%
Fuel Economy	18.2%	70.5%	11.4%
Power / Handling	18.2%	68.2%	13.6%
Preference of the flotilla (manager or owners)	11.4%	88.6%	0.0%
Credit availability	11.4%	79.5%	9.1%
Preference of the operators	9.1%	79.5%	11.4%
Preference of the workshop / service manager	4.5%	86.4%	9.1%
Contractual Obligations of the Company	4.5%	88.6%	6.8%
To retain good operators	2.3%	86.4%	11.4%

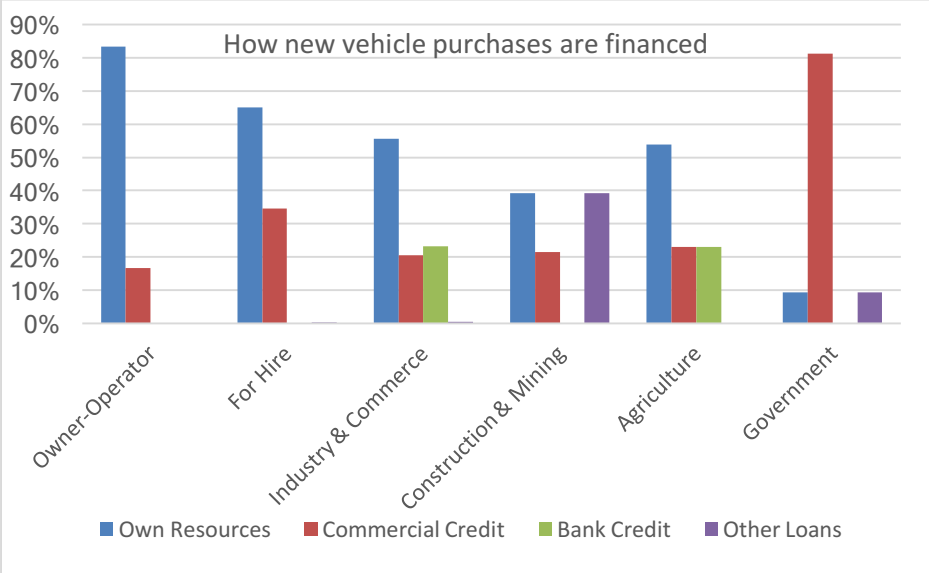
How purchases are financed

The predominant means of buying a highway tractor or semi-trailer is through the application of the fleet's own resources (equity). Around 70 percent of units are purchased in this way, due to the difficulty of accessing financing (see Table 32). However, over the last five years this situation has changed slightly; financing highway tractors through OEMs and leasing semi-trailers have become the second most important acquisition method. Bank loans to buy units have diminished over this period from 3 percent five years ago to 0 percent today. Interviewees cite high interest rates and high collateral requirements (not enough equity) as being the main reason for this.

Table 32 - How the purchase of a unit was financed

	Highway Tractors		Semi-trailers	
	Now	5 years ago	Now	5 years ago
	%	%	%	%
Own funds (Equity)	69.2%	71.4%	69.6%	77.1%
Financing through OEM	15.4%	8.6%	8.7%	5.7%
Leasing	11.5%	5.7%	17.4%	5.7%
Private loan	3.8%	8.6%	4.3%	8.6%
Bank loan	0.0%	2.9%	0.0%	2.9%
Rent	0.0%	0.0%	0.0%	0.0%
Other	0.0%	2.9%	0.0%	0.0%

More vocational detail on how purchases were funded 5 years ago is provided by the TSTES INECC survey. Figure 33 (and Table 33) show how highway tractor purchases were financed. Bank credit was an option only for Industry, Commerce and Agricultural companies that have good credit ratings. For Hire fleets do not have this option and are more dependent on the Commercial credit offered by the company selling the vehicle. Owner/operators purchase over 80 percent of their vehicles using their own resources, because of the lack of alternatives. They typically have older vehicles with low annual mileages, low load factors, and very limited access to finance, which makes it very difficult for them to buy newer vehicles. For Hire fleets also have limited access to bank finance but are more creditworthy with vehicle dealers. Government (although the sample size is very limited) depend almost exclusively on commercial credit to buy vehicles.



Source: TSTES field study for INECC (2011)

Figure 33 - How highway tractor purchases were financed

Table 33 - How highway tractor purchases were financed

Highway Tractors	O/Operator	For Hire	Ind&Com	Con&Min	Acric	Gov	Total
Total vehicles	6	2,353	344	107	13	32	2,855
Own Resources	5	1,529	191	42	7	3	1,777
Commercial Credit	1	813	71	23	3	26	937
Bank Credit	0	1	80	0	3	0	84
Other Loans	0	10	2	42	0	3	57
percent							
Own Resources	83%	65%	56%	39%	54%	9%	62%
Commercial Credit	17%	35%	21%	21%	23%	81%	33%
Bank Credit	0%	0%	23%	0%	23%	0%	3%
Other Loans	0%	0%	1%	39%	0%	9%	2%

Source: TSTES field study for INECC (2011)

Current problems with financing

Interviewees cited interest rate as the principal problem for private loans and rental payments, causing their participation to diminish over the last 5 years as other attractive options became available. Despite being expensive, leasing has increased its participation particularly for semi-trailers. Whilst OEM financing is becoming the predominant source of external funding for highway tractors, the main problems getting OEM financing for new vehicles are high interest rates, difficulty in proving adequate income, loan period too short and the vehicle not always being considered as collateral for the loan (see

Table 34). Financing for the purchase of used vehicles is very scarce from any source. This particularly impacts owner-operators and smaller fleets that do not generate the cash follow to warrant a new vehicle purchase.

Table 34 - Problems associated with obtaining finance

Problems associated with getting financing	From the Manufacturer	From the Bank	Private Loan	Leasing	Rent
	%	%	%	%	%
Interest rate too high	46.2%	71.4%	100.0%	100.0%	100.0%
Do not finance used vehicles	23.1%	14.3%	0.0%	0.0%	0.0%
Cannot prove adequate income	19.2%	0.0%	0.0%	0.0%	0.0%
Loan Period too short	7.7%	0.0%	0.0%	0.0%	0.0%
Vehicle not taken as guarantee	3.8%	0.0%	0.0%	0.0%	0.0%
Not sufficient equity	0.0%	14.3%	0.0%	0.0%	0.0%
Responses	26	7	3	3	1

Expected purchases over the coming 24 months

The interviewees were questioned about their plans to buy and sell units over the next 24 months (Table 35 gives their responses for highway tractors and Table 36 for semi-trailers). Overall, the interviewees expect to reduce their ownership in 15 percent for highway tractors and 11 percent in semi-trailers. However, there are different trends within some categories, looking at the two main vocational groups: “For hire” expects a net increase of 3 percent in highway tractors and 2 percent in semi-trailers whilst “Industry and Commerce” are looking at a considerable reduction in both of 33 and 22 percent respectively. This is not because they see their business declining; it is caused by a considerable shift towards the use of 3PL companies to manage their complete transportation needs. One advantage of this shift, is that they will avoid the limitation on private fleets that have foreign investment of transporting only those goods that are directly related to their business needs. For example, because of regulation a Coca Cola owned truck cannot carry bottled water from a sister company on its return trip. However, a 3PL owned truck in Coca Cola livery is not subject to these restrictions which gives it a great advantage in transport efficiency.

Table 35 - Number of Highway Tractors that are expected to be bought or sold over the coming 24 months

Highway Tractors

Number of vehicles	For Hire	Industry & Commerce	Construction & Mining	Agriculture	Owner-Operator	Other	Total
Plan to buy							
2015 & later	194	10	0	0	0	2	206
Plan to sell							
2015 & later	0	0	0	0	0	0	0
2013 - 2014	60	480	0	0	0	0	540
2009- -2012	44	199	0	0	0	0	243
2005 - 2008	15	18	0	0	0	0	33
2001 - 2004	13	7	0	0	1	0	21
1997 - 2000	6	32	0	0	0	0	38
1993 - 1996	0	3	0	0	0	0	3
1989 - 1992	3	0	0	0	0	0	3
1985 - 1988	0	0	0	0	0	0	0
1981 - 1984	0	0	0	0	1	0	1
1977 - 1980	0	0	0	0	0	0	0
1973 - 1976	0	0	0	0	0	0	0
1972 & earlier	0	0	0	0	0	0	0
TOTAL	141	739	0	0	2	0	882
Difference	53	-729	0	0	-2	2	-676
Number owned	2005	2182	395	19	23	26	4650
Percent change	2.6%	-33.4%	0.0%	0.0%	-8.7%	7.7%	-14.5%

Table 36 - Number of Semi-trailers that are expected to be bought or sold over the coming 24 months

Semi-trailers

Number of vehicles	For Hire	Industry & Commerce	Construction & Mining	Agriculture	Owner-Operator	Other	Total
Plan to buy							
2015 & later	70	5	0	0	0	14	89
Plan to sell							
2015 & later	0	0	0	0	0	0	0
2013 - 2014	0	0	0	0	0	0	0
2009- -2012	0	0	0	0	0	0	0
2005 - 2008	0	809	0	0	0	0	809
2001 - 2004	10	177	0	0	1	0	188
1997 - 2000	0	19	0	0	0	0	19
1993 - 1996	5	42	0	0	0	0	47
1989 - 1992	0	12	0	0	0	0	12
1985 - 1988	0	2	0	0	0	0	2
1981 - 1984	0	1	0	0	0	0	1
1977 - 1980	2	0	0	0	0	0	2
1973 - 1976	0	0	0	0	0	0	0
1972 & earlier	0	0	0	0	0	0	0
TOTAL	17	1062	0	0	1	0	1080
Difference	53	-1057	0	0	-1	14	-991
Number owned	3562	4895	644	24	27	24	9176
Percent change	1.5%	-21.6%	0.0%	0.0%	-3.7%	58.3%	-10.8%

Chapter 5:- Tractor-trailer Usage and Operating Costs

This chapter compiles information on the how various types of fleets differ in terms of operating patterns. It looks at tractor-trailer usage, trip length and frequency. It evaluates fuel economy and other operating costs, with details by age of vehicle and by vocation.

Chapter Highlights

Highway tractor kilometers per year

In general terms, the annual use of highway tractors is reduced as their age increases. New units operate on average around 140,000 kms per year. By the time they are 20 years old this average annual usage has dropped to around 100,000 kms and by the time they are 30 years old the annual average usage is around 50,000 kms per year. This change in usage is brought about by changes in ownership.

The overall average annual mileage per vehicle in this latest combined sample is 131,000 kms. In the MacKay study (2015) the average annual mileage per vehicle was 128,000 kms, which is 12 percent higher than the average in the USA at that time.

Highway tractor number of trips and trip length

Industry and Commerce

"Industry and Commerce" fleets tend to run daily trips of 400 to 600 kms with newer vehicles at the high end of this scale and older vehicles running around 50 percent less trip lengths. They tend to use highway tractors of up to 25 years old, whilst there are some outliers. When the vehicle is no longer apt for their routes, they tend to get sold to Owner-operators. Annual mileage for these vehicles starts around 115,000 kms over the first 8 years of life, and drops to around 65,000 kms over 25 years.

For Hire

"For Hire" fleets tend to operate almost half the number of trips per month compared to "Industry and Commerce" fleets and this varies little with the age of the vehicle. However, the average trip length does get reduced as the highway tractor grows older and is passed from large fleets to medium and smaller brethren. The newer highway tractors of up to 6-8 years old in "For Hire" fleets tend to operate in the large fleets with trip lengths of around 1,500 kms. These vehicles then get passed to medium fleets that tend to run on secondary or more geographically challenging routes with an average trip length of 800 to 900 kms. The oldest vehicles (of around 30 years old) tend to be used in low mileage, feeder, and pick-up and delivery service. As a result, highway tractors in "For Hire" fleets have annual mileages that start around 135,000 kms per year (which is one-quarter higher than Industry and Commerce) and drop to one-tenth of this value as they get older. When they get absorbed by Owner-operators, their usage tends to change to far fewer but longer trips giving similar annual mileages or less km.

Interviewees in this vocation reported for vehicles over 15 years old, routes of 3 to 7 trips per month generating annual mileages of 35,000 kms

Fuel Economy

Fuel economy of highway tractors has improved considerably over recent years. Nationwide, on average, tractor-trailer fuel economy in new units is 42 percent better than in 30-year old units.

For Hire

For "For Hire" fleets the latest survey shows an average fuel economy for a 30-year-old truck of 1.7 km/L compared with 2.6 km/L for a new unit. Note that the true efficiency improvement is greater than these numbers suggest because the new units tend to be in longer trips with higher road speeds than their older brethren. Many fleets comment that this difference in fuel consumption is almost sufficient to cover the monthly payment against buying a new vehicle.

Industry and Commerce

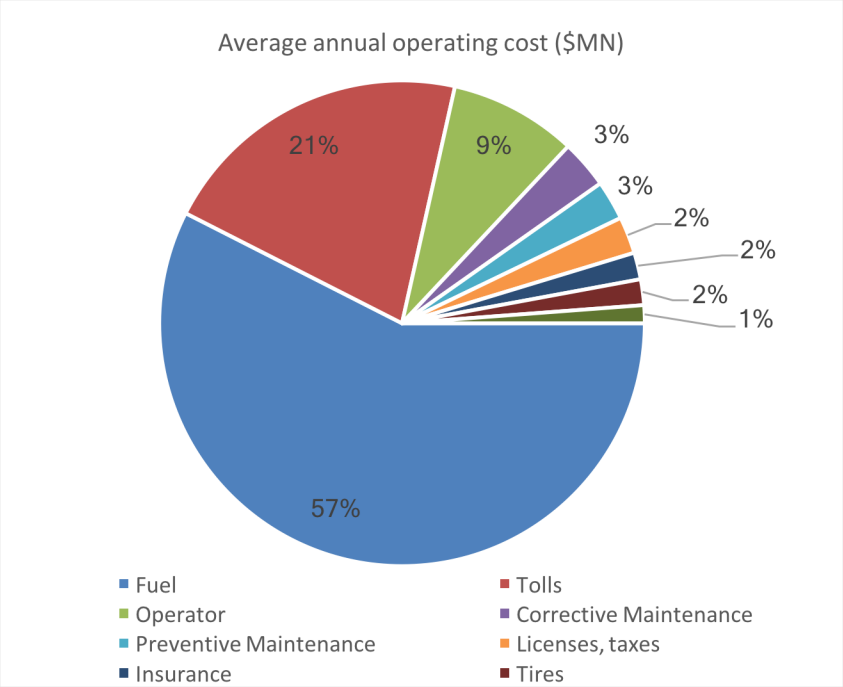
The "Industry and Commerce" vocation sees similar fuel economies on old trucks than "For Hire" but less improvement with new units mainly because of the increasing use of doubles (or full) with a maximum GVW of 66.5 tons (with a higher limit of 75.5 tons on road types "ET" and "A") compared to 38 tons for a standard "T3-S2" rig on class "B" roads. It is important to note that the fuel economy per kg transported is considerably higher in a double configuration.

It is interesting to note the impact of the change in drive cycle on fuel economy as vehicles get older and get passed from principal freight routes to secondary or feeder operations in small fleets and with owner-operators. The normal drive cycle in Mexico applicable to main route operation gives an expected fuel economy of 3.3 km/L (for EURO III, 34 – 40 tons GCW) whilst the same vehicle in a lighter feeder-operation drive cycle with lower load and less highway operation gives an expected fuel economy of 4.2 km/L. In practice, lower fuel economies are reported due to (i) the use of doubles or fulls, (ii) maintenance and driving practices; and (ii) the more difficult route conditions on the secondary and feeder routes.

Operating Expenses

Including operator and fuel, at 2017 prices, expenditure per kilometer increases slightly from around 10.5 pesos/km over the first 6 – 8 years to almost 12 pesos/km after 25 years of use. Excluding Operator and Fuel, the For-Hire fleets have the lowest average cost per kilometer ($3.4 MN/km) whilst Industry and Commerce show an average expense of $7.5 MN/km. Significant differences in the expenses by vocation exist. The "For Hire" reports spending more than "Industry and Commerce" in Licenses & taxes, and Insurance; and considerably less in Tolls and Corrective Maintenance.

Operating Expenses (cont)



As a percent of operating costs, excluding Truck/trailer lease or purchase payments, fuel costs in Mexico are highest representing 57 percent of the total expenditure, whilst in the USA, fuel represents only 43 percent. This is partially due to the higher driver wages and benefits in the USA* – which account for 38 percent as compared to 9 percent in Mexico

Data collected on in-use tractor-trailers in Mexico

The interviewees were asked which agency collects information about vehicles and their use (km/year) in Mexico. Their overall conclusion was sadly that little systematic data is collected. SCT does process vehicle registration data but usage data only comes from limited ad-hoc studies commissioned by them, CANACAR, CANAPAT, ANTP (Asociación Nacional de Transporte Privado) and SEMARNAT in their "Transporte Limpio" program.

The last question was about the data that the fleet or operator regularly collect. Interestingly, only 36 percent of the interviewees reported keeping regular records and reports on vehicle operation and efficiency (see Table 79). Of the data collected, fuel consumption per vehicle was the most common response, followed by vehicle maintenance records and number of trips and mileage per vehicle.

Note * Source "Barriers to the adoption of fuel-saving technologies in the trucking sector" ICCT July 2017 see http://www.theicct.org/sites/default/files/publications/HDV-fuel-saving-tech-barriers_ICCT-briefing_07072017_vF.pdf

The role of the different types of fleets

The on-road, highway tractor, freight transport in Mexico is clearly divided into two segments:

- Private transport – companies that have fleets to transport the products that they manufacture or distribute; and
- For Hire - fleets that transport good for others

A relatively new modality in Mexico are the third-party logistics companies (3PL) which provide seamless transport services to manufacturers and distribution companies, often with trucks and personnel in the client's livery. Logistics companies are not yet as prevalent in Mexico as they are in the U.S. for they are still generally considered as too expensive for the Mexican market but they are beginning to play a larger part, with year-on-year growth rates that far exceed the average for the Mexican trucking industry.

The traditional advantages of outsourcing supply chain management to a 3PL leverage their having a larger fleet than the client company by itself would have, which results in economy of scale, and being businesses that are totally focused on transport (whereas the client's focus is on his core production business where transport is but a necessary part). Large 3PLs also provide flexible and scalable services that accommodate seasonality and growth. However, even for a 3PL with limited clients, there can be significant advantages:

- As can be seen in a later section of this study, For Hire fleets (whose business is transport) tend to be more efficient than private fleets' transport operations
- Frees-up the capital requirement of owning a fleet, releasing valuable equity and management resources, and converting transport into a variable cost; and
- A big thing in Mexico, allows freight to be more easily carried on both the outward and return journey trips.

Private transport in Mexico in companies that have foreign investment (equity) are not allowed to transport goods for other companies. This makes it difficult for a tractor-trailer that is delivering goods to a distribution center or client, to swing-by a supplier, or Sister Company and get a full load for the return trip. 3PLs are not subject to these limitations.

Whilst large professionally managed fleets need little or no government help due to their financial muscle and their depth of knowledge about their own operations, small fleets and owner-operators remain an important challenge, particularly for the Transporte Limpio and similar programs.

The owner-operators and small fleets, represent a large portion of the registered fleet, have the oldest vehicles, and notably lower efficiency than their larger brethren. As previously mentioned they tend to have considerably lower annual mileages and lower load factors, operating on difficult routes that are not attractive to the larger fleets or on local feeder operations.

Owner-operators provide transport services to the clients who do not require controls such as ISO 9000[29]; and who pay cash. They will often choose the client who pays less but pays faster because many exist on a cash-flow basis and liquidity is essential.

Owner-operators provide transport for low-value loads (for example for oranges from Merida to Mexico City) that cannot afford a higher cost service. These are loads that will never go to the large carrier, they will always go with whoever provides the cheapest service.

Owner-operators do not typically participate in the more formal market that looks for a well constituted company that offers a tracking system, insurance, and a lot of factors, such as certification, and the assurance that the driver will mot mess with the load. There are many advantages to hiring a well-established company rather than an owner-operator; it is not the same transporting oranges as moving, for example, cyanide.

Most stakeholders interviewed, including government agencies such as the SMAEM recognize the need for improved education and knowledge distribution to these smaller operators, to increase their understanding of cost/benefit analysis and other basic analytical tools. According to interviewee Rafael Tapia Velázquez, better information and training would allow the smaller enterprises to better observe factors, such as energy consumption, that they may not be currently monitoring. Transport programs, including but not limited to the scrappage & renewable scheme, would benefit greatly from smaller enterprises understanding the process and benefits of such programs.

Highway tractor kilometers per year

The average vehicle usage by age and vocation was determined from field surveys of 179 fleets that owned 9601 class 8 highway tractors. The results of these surveys are shown in Table 37 and Figure 34. They are of course limited by the age of the vehicles in each sample. For example, the Government vocation sample does not contain any vehicles of between 9 and 28 years of use.

In general terms (not vocation specific) the annual use of highway tractors is reduced as their age increases (see Figure 34). New units operate on average around 140,000 kms per year. By the time they are 20 years old this average annual usage has dropped to around 100,000 kms and by the time they are 30 years old the annual average usage is around 50,000 kms per year. As we will see by vocation, this change in usage is brought about by changes in ownership.

[29] **ISO 9000** is a set of international standards on quality management and quality assurance developed to help companies effectively document the quality system elements to be implemented to maintain an efficient quality system. They are not specific to any one industry and can be applied to organizations of any size.

Table 37 - Average kms by age of vehicle by Vocation

Number of fleets	Years in use										
	Total	1-4	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	over 40
Owner/Oper	20	1	2	4	3	3	3	3	2	0	0	1
For Hire	98	31	22	20	20	6	3	4	1	3	1	1
Ind & Com	23	7	7	2	6	0	2	2	0	0	0	0
Const & Min	12	2	2	4	5	1	0	0	0	0	0	0
Agriculture	21	3	5	6	2	2	3	3	0	0	0	0
Government	5	1	1	0	0	0	0	0	2	1	0	0
Total	179	45	39	36	36	12	11	12	5	4	1	2

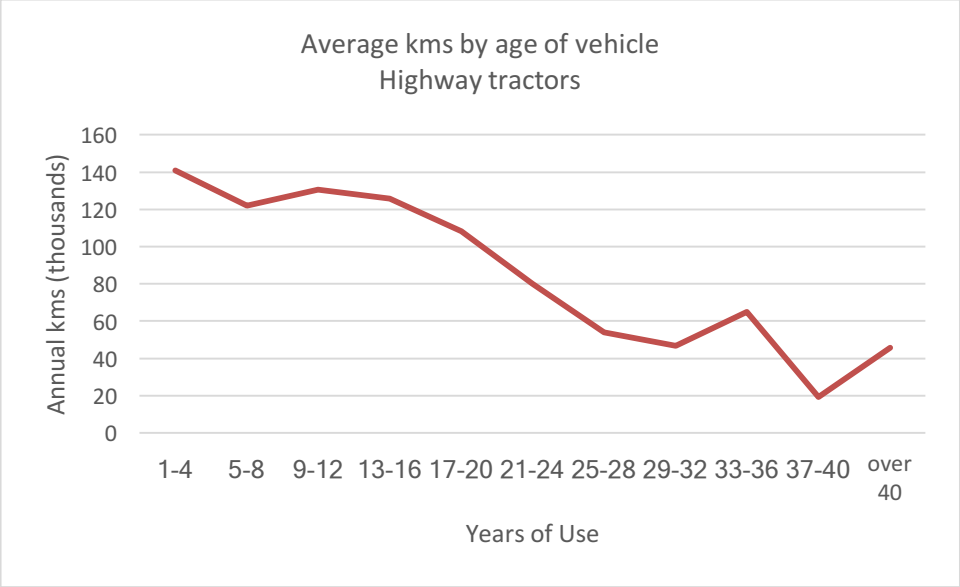
Number of vehicles	Years in use										
	Total	1-4	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	over 40
Owner/Oper	49	4	12	10	8	7	4	1	2	0	0	1
For Hire	8489	3886	2921	1000	478	118	59	14	2	8	2	1
Ind & Com	468	267	41	37	96	3	24	0	0	0	0	0
Const & Min	206	101	23	38	38	5	1	0	0	0	0	0
Agriculture	357	33	49	115	102	39	17	2	0	0	0	0
Government	32	4	22	0	0	0	0	0	5	1	0	0
Total	9601	4295	3068	1200	722	172	105	17	9	9	2	2

Average annual kms	Years in use										
('000 km)	Total	1-4	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	over 40
Owner/Oper	100.2	180.0	155.0	124.2	70.0	100.0	49.1	9.0	46.7	0.0	0.0	72.0
For Hire	133.3	143.0	122.6	135.9	131.6	88.4	73.6	52.0	19.2	66.4	19.2	19.2
Ind & Com	126.7	135.3	110.9	148.9	122.6	0.0	70.0	0.0	0.0	0.0	0.0	0.0
Const & Min	81.0	84.8	80.0	74.8	75.1	11.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	126.1	134.7	123.8	97.1	125.0	190.0	128.8	89.0	0.0	0.0	0.0	0.0
Government	72.1	75.6	75.6	0.0	0.0	0.0	0.0	0.0	57.6	54.0	0.0	0.0
Total	131.2	141.1	122.0	130.5	125.8	108.1	80.1	53.8	46.6	65.0	19.2	45.6

Source: TSTES field studies including Mackay (2015) and INECC (2011)

The overall average annual mileage per vehicle in this combined sample is 131,000 kms. In the MacKay study (2015) the average annual mileage per vehicle was 128,000 kms, which is 12 percent higher than the average in the USA[30].

[30] MacKay reports the US 2015 Average Annual Kilometers per Class 8 vehicle as 114,000 km.

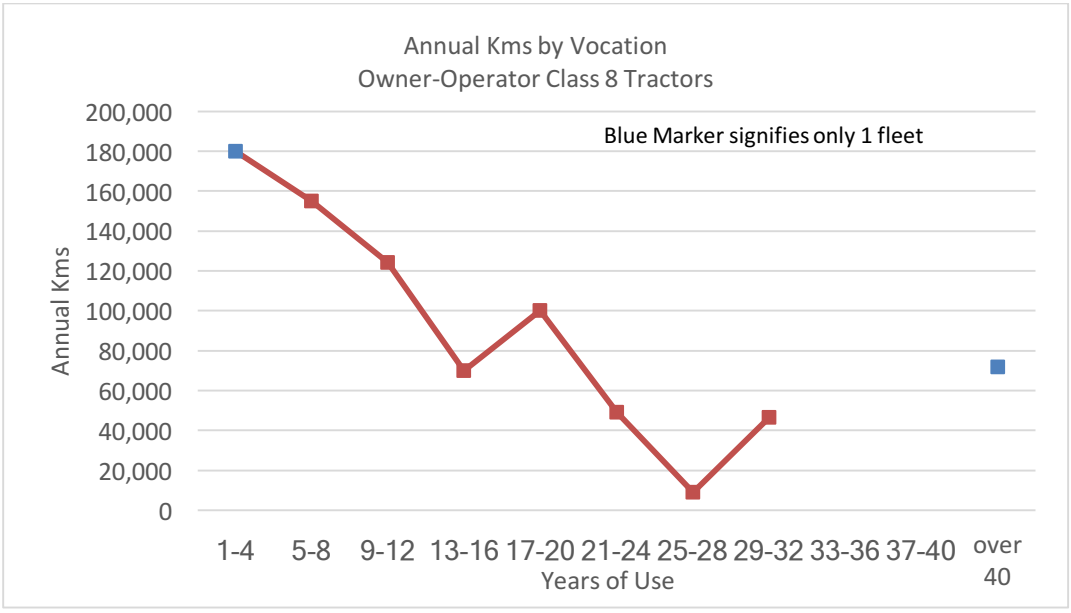


Source: TSTES field studies including Mackay (2015) and INECC (2011)

Figure 34 - Average kms by age of vehicle

Owner-operator

For the vocation of Owner-operator the combined sample consisted of 49 vehicles pertaining to 20 owners. These exhibit a sharp decline in usage with age (Figure 35) with a characteristic "saw-tooth" pattern that is thought to align with general vehicle overhaul at around 15 years and 27 years of age. This is reflected in Figure 20 in Chapter 3 which shows by model year the fraction of vehicles that have the original un-overhauled engine.

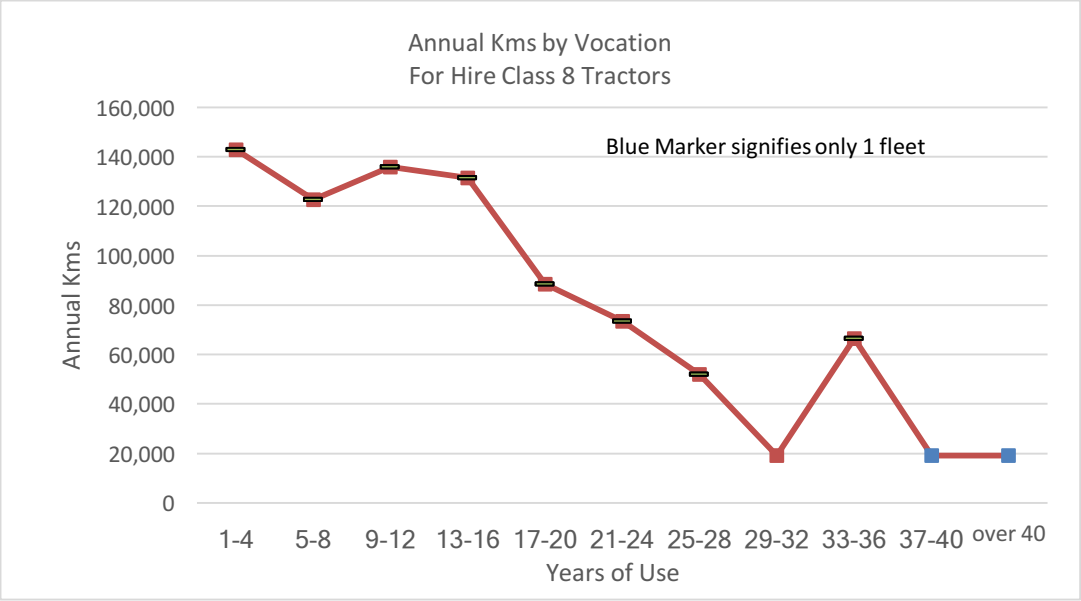


Source: TSTES field studies including Mackay (2015) and INECC (2011)

Figure 35 - Owner / operator; Average kms by age of vehicle

For Hire Fleets

The vocation with most fleets and vehicles in this sample is the "For hire" category (98 fleets with 8489 highway tractors). This also exhibits a steady decline in usage with age (Figure 36) from 143,000 kms per year when new to around 20,000 kms after 30 years of service.

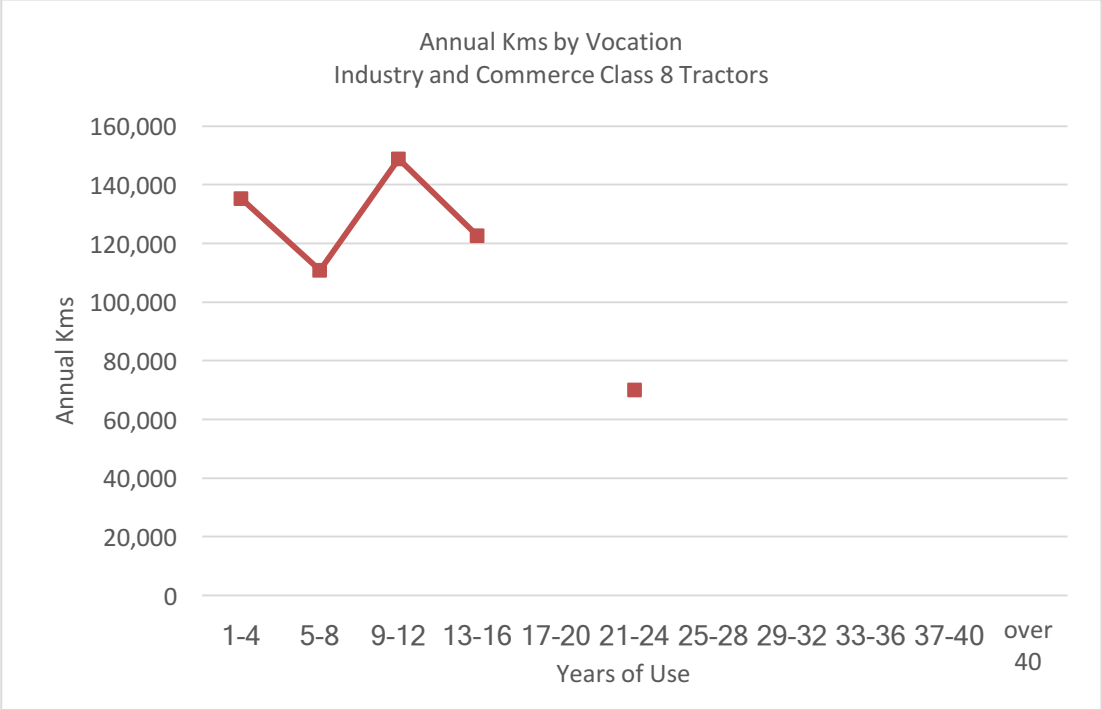


Source: TSTES field studies including Mackay (2015) and INECC (2011)

Figure 36 - For hire; Average kms by age of vehicle

Industry & Commerce

Industry & Commerce similarly exhibits an almost constant annual mileage—of around 135,000 kms--for the first 15 years of use. This sample has an additional data point at 21 to 24 years of use where the reported annual mileage is half, at around 70,000 kms.

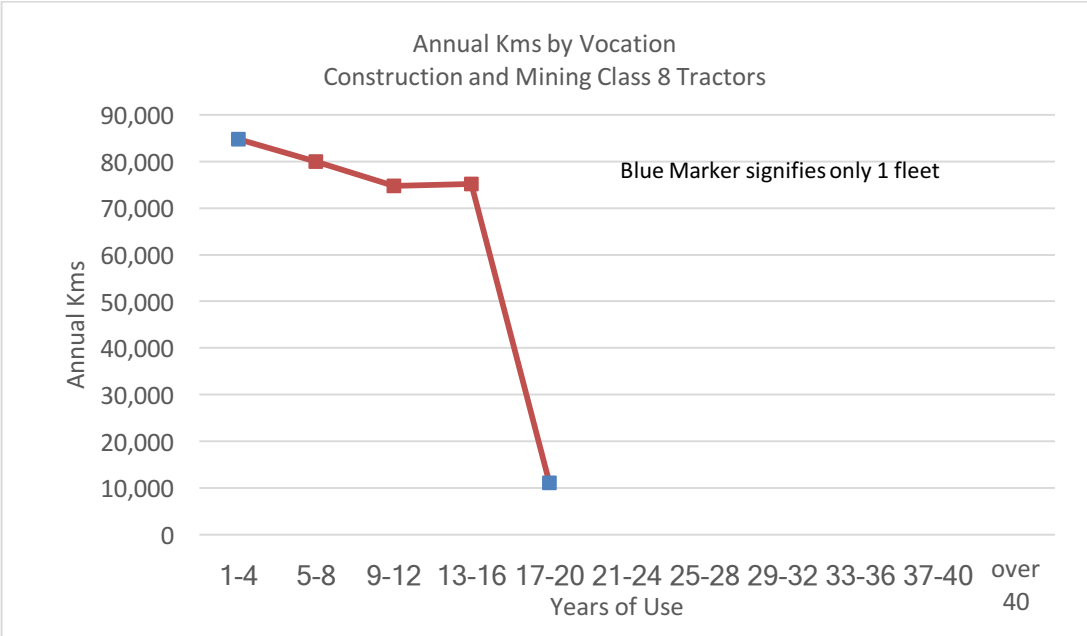


Source: TSTES field studies including Mackay (2015) and INECC (2011)

Figure 37 - Industry & Commerce; Average kms by age of vehicle

Construction & Mining

The Construction & Mining presence in the field sample is smaller consisting of 206 highway tractors operated by 12 fleets. Of these, all except 6 units were between 0 and 16 years of age running an average of about 80,000 kms per year (see Figure 38).



Source: TSTES field studies including Mackay (2015) and INECC (2011)

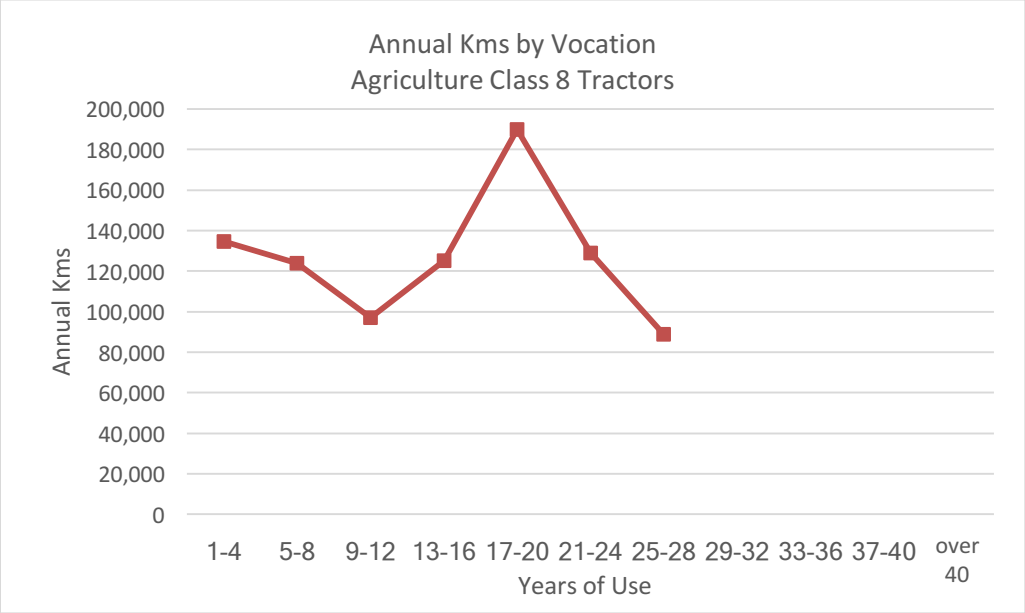
Figure 38 - Construction & Mining; Average kms by age of vehicle

Agriculture

The Agriculture presence in the field sample consists of 357 highway tractors operated by 21 fleets. These exhibit an average usage of 126,000 kms per year (see Figure 39), with the highest usage for units of 17-20 years old (190,000 kms per year). This high mileage according to the interviewees, is due to the special conditions of this seasonal market where there is a very high demand during the harvest season but year-round cannot justify a larger dedicated fleet, or newer vehicles. For example, Sinaloa is the country's largest vegetable producer and the leading USA supplier of tomatoes and other fresh produce in winter. It currently transports 90% of its fresh vegetable exports via Nogales with the remainder taking the northern logistic corridor from Mazatlán to Texas[31].

During the harvest season, more than 200 trailers per day use the same routes; either the link from Sinaloa to Nogales which is a distance is 976 km with a normal transit time of 8 hours, or the Mazatlán to Texas route which is 1200 kms long and used to take 20 hours but with the new highways has been reduced to 15 hours driving time. Here they are delivered to intermediaries who distribute them in the USA. In season, these units stop only for loading/unloading and accumulate very high mileage.

[31] Source: Manuel Tarriaba Urtuziástegui, Horticultivos edition march 13, 2017, and Google maps.

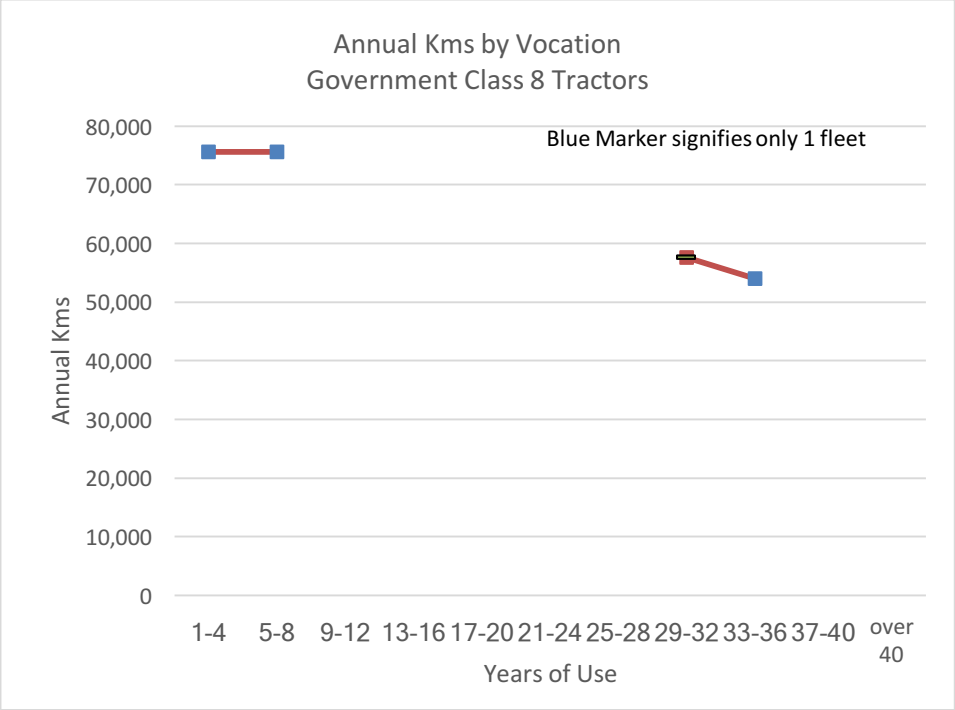


Source: TSTES field studies including Mackay (2015) and INECC (2011)

Figure 39 - Agriculture; Average kms by age of vehicle

Government

The Government sample size (32 highway tractors operated by 5 agencies) is too small to provide significant results by age of vehicle. On average, these units operate around 72,000 kms per year (see Figure 40).



Source: TSTES field studies including Mackay (2015) and INECC (2011)

Figure 40 -- Government; Average kms by age of vehicle

Highway tractor number of trips and trip length

The following figures (Figure 41 and Figure 42) and tables (Table 38 and Table 39) illustrate how the duty cycle of highway tractors changes, for different vocations, by age of vehicle. "Industry and commerce" fleets tend to run daily trips of 400 to 600 kms with newer vehicles at the high end of this scale and older vehicles running around 50 percent less trip lengths. They tend to use highway tractors of up to 25 years old (see Figure 26), whilst there are some outliers. When the vehicle is no longer apt for their routes, they tend to get sold to Owner-operators. Annual mileage for these vehicles starts at around 115,000 kms over the first 8 years of life, and drops gradually to around 65,000 kms after 25 years.

"For Hire" fleets tend to operate almost half the number of trips per month than "Industry and Commerce" fleets and this varies little with the age of the vehicle. However, the average trip length does get reduced as the highway tractor grows older and is passed from larger fleets to medium and smaller brethren. The newer highway tractors of up to 6-8 years old in "For Hire" fleets tend to operate in the larger fleets with trip lengths of around 1,500 kms. These vehicles then get passed to medium fleets that tend to run on secondary or more topographically, and road trace and surface challenging routes with an average trip length of 800-900 kms. The oldest vehicles (of around 30 years old) tend to be used in low mileage, feeder, and pick-up and delivery service. As a result, highway tractors in "For Hire" fleets have annual mileages that start around 135,000 kms per year (which is one-quarter higher

than Industry and Commerce) and drop to one-tenth of this value as they get older. When they get absorbed by Owner-operators, their usage tends to change to fewer but longer trips, without disrupting this tendency for annual mileages to be reduced as the vehicle gets older. Interviewees reported for vehicles over 15 years old, routes of 3 to 7 trips per month generating annual mileages of 35,000 or less km.

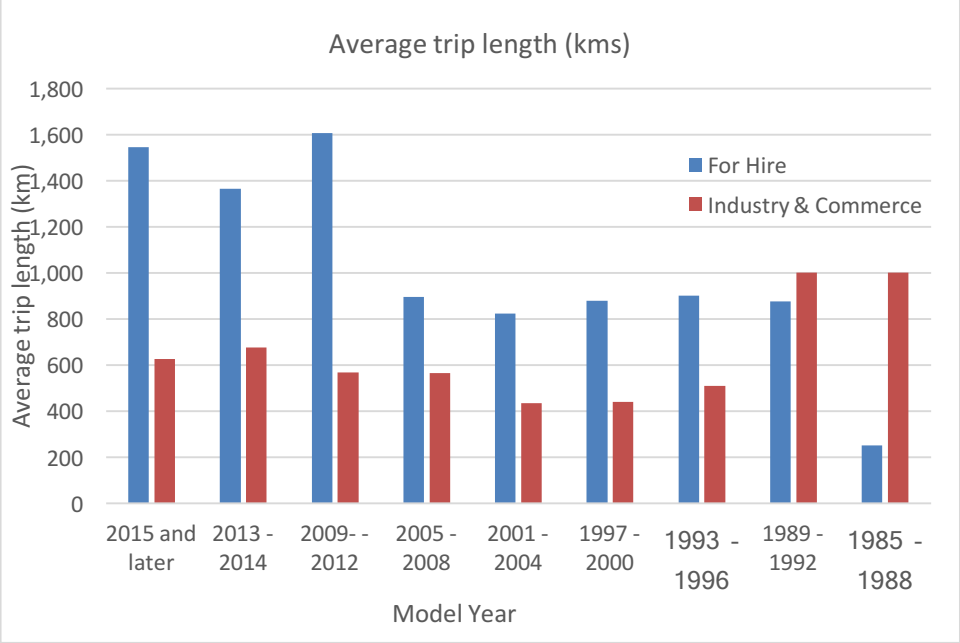


Figure 41 - Average trip length (kms) by age and vocation

Table 38 - Average trip length (kms) by age and vocation

Highway Tractors

Average Trip Length	For Hire	Industry & Commerce	Construction & Mining	Agriculture	Owner-operator	Other	Total
2015 & later	1,544	626	300			200	989
2013 - 2014	1,366	676	300	1,200		200	889
2009- -2012	1,607	567		1,200	1,500		1,025
2005 - 2008	896	566	900	1,200	874		733
2001 - 2004	822	433	900	1,200	1,700		588
1997 - 2000	878	441	900				780
1993 - 1996	901	510		700	743		680
1989 - 1992	875	1,000					942
1985 - 1988	250	1,000			1,550		987
1981 - 1984					610		610
TOTAL	1,340	608	320	1,042	1,136	200	901

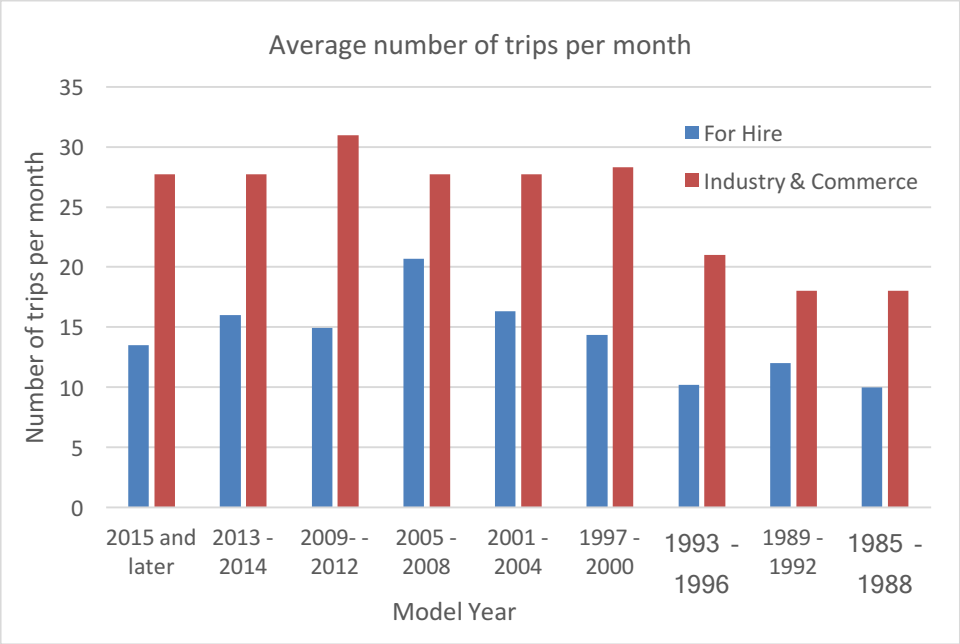


Figure 42 - Average number of trips per month by age and vocation

Table 39 - Average number of trips per month by age and vocation

Highway Tractors

Trips per month	For Hire	Industry & Commerce	Construction & Mining	Agriculture	Owner-operator	Other	Total
2015 & later	14	28	28			28	21
2013 - 2014	16	28	28	8		28	23
2009- -2012	15	31		8	10		24
2005 - 2008	21	28	7	8	12		24
2001 - 2004	16	28	7	8	4		23
1997 - 2000	14	28	5				17
1993 - 1996	10	21		4	7		15
1989 - 1992	12	18					15
1985 - 1988	10	18			3		16
1981 - 1984					10		10
TOTAL	15	28	27	7	9	28	22

Fuel Economy

Data from the survey responses suggests that fuel economy of highway tractors has improved considerably (see Figure 43 and Table 40). For “For Hire” fleets the interviewees presented data showing

an average fuel economy for a 30-year-old truck of 1.7 km/L compared with 2.6 km/L for a new unit. Note that the true efficiency improvement is greater than these numbers suggest because the new units tend to be in longer trips with higher road speeds than their older brethren. Many fleets comment that this difference in fuel consumption is almost sufficient to cover the monthly payment against buying a new vehicle.

The "Industry and Commerce" vocation sees similar fuel economies on old trucks to "For Hire" but less improvement with new units mainly because of the increasing use of double trailers (or full) with a maximum GVW of 66.5 tons (with a higher limit of 75.5 tons on road types "ET" and "A") compared to 38 tons for a standard "T3-S2" rig on class "B" roads. It is important to note that the fuel economy per kg transported is considerably higher in a double configuration.

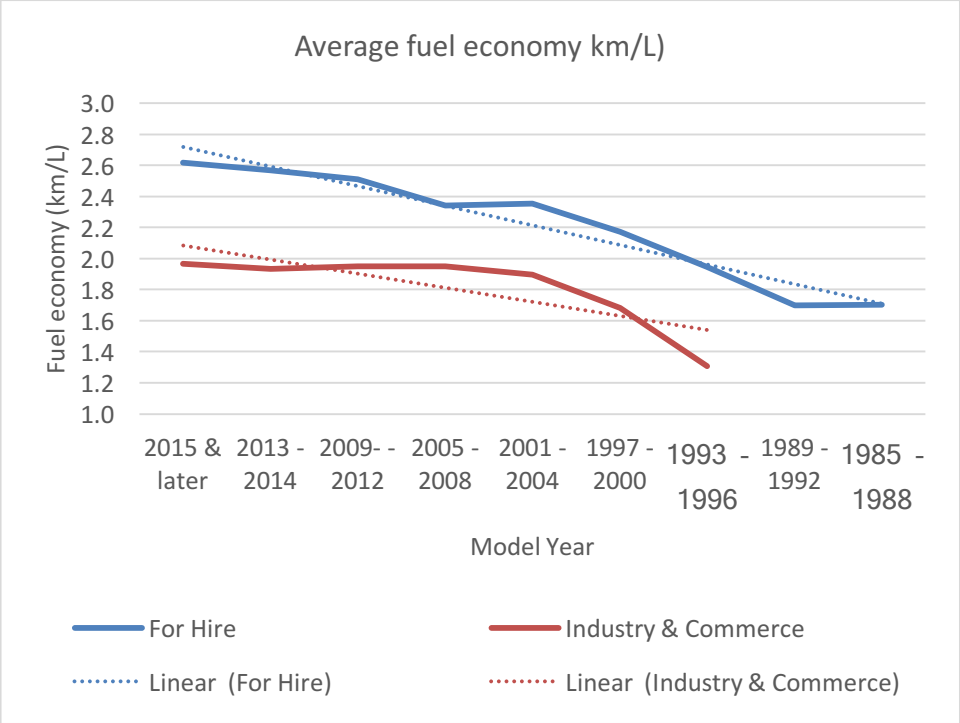


Figure 43 - Average fuel economy km/L) by age and vocation

Table 40 - Average fuel economy km/L) by age and vocation

Highway Tractors

Average Fuel Economy	For Hire	Industry & Commerce	Construction & Mining	Agriculture	Owner-operator	Other	Total
2015 and later	2.62	1.97	1.40			2.70	2.18
2013 - 2014	2.57	1.93	1.40	2.10		2.70	2.13
2009- -2012	2.51	1.95		2.10			2.34
2005 - 2008	2.34	1.95	1.91	2.10	2.11		2.13
2001 - 2004	2.35	1.90	1.91	2.10	2.00		2.05
1997 - 2000	2.17	1.68	1.50				2.05
1993 - 1996	1.94	1.31		2.00	2.00		1.63
1989 - 1992	1.70	1.75					1.73
1985 - 1988	1.70	1.70			1.70		1.70
1981 - 1984					1.45		1.45

It is important to note, additionally, the impact of the change in drive cycle on fuel economy as vehicles get older and get passed from the principal long haul freight routes to secondary or feeder operations in small fleets and with owner-operators. To illustrate the point, the fuel economy of tractor-trailer combinations (EURO III, 34 – 40 tons GCW) were calculated using the European COPERT (version 4.53) emissions model assuming an ambient monthly max/min temperature as per Guadalajara, no altitude compensation and no mileage degradation under the two different drive cycles shown in Table 41. The normal drive cycle applicable to principal route operation gives an expected fuel economy of 3.3 km/L whilst the same vehicle in a lighter feeder-operation drive cycle with lower load and less highway operation gives an expected fuel economy of 4.2 km/L. In practice, lower fuel economies are reported due to (i) the use of double trailers or full trailers[32], (ii) maintenance and driving practices; and (ii) the more topographically, and road trace and surface challenging route conditions on the secondary and feeder routes.

All these factors affect fuel consumption: engine and drivetrain maintenance can have a direct impact on the specific fuel economy where items such as restrictive air filters or exhaust systems, and poor atomization of fuel in the engine's cylinders reduce the power obtained from the fuel consumed. Good driving practices, avoiding abrupt changes in speed, maintaining the correct gear, and anticipating road conditions can improve fuel economy by sometimes more than 30 percent. Road conditions that cause more stopping and starting and accelerations also have a negative impact on fuel economy, as does

[32] A **full trailer** is a term used in Mexico and the United States for a freight **trailer** supported by front and rear axles and pulled by a drawbar. For a tractor-trailer combination this is only applicable to the second trailer that is pulled behind the semi-trailer that is mounted on the tractor's fifth wheel.

changes in altitude. Increasing the loaded combined weight of the tractor-trailer combination reduces vehicle fuel economy, but interestingly can improve the fuel consumption per ton-kilometer transported.

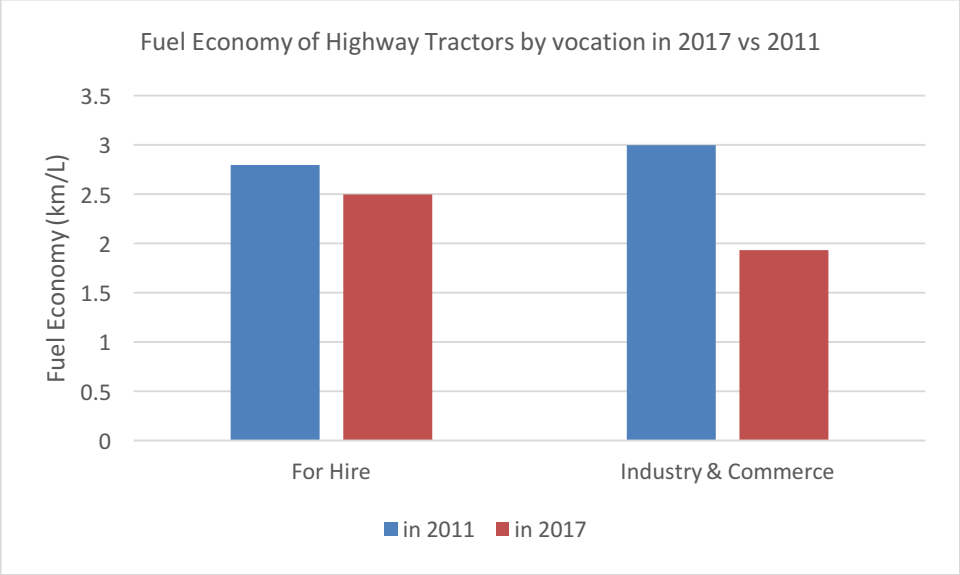
Table 41- Illustrative drive cycle examples

"Normal Use" considers 50% load			"Light Use" considers 10% load		
Operation	Average Speed (kph)	Driving Share %	Operation	Average Speed (kph)	Driving Share %
Urban	20	10%	Urban	20	10%
Rural	60	22.4%	Rural	60	67.6%
Highway	100	67.6%	Highway	100	22.4%
Expected fuel economy of 3.3 km/L			Expected fuel economy of 4.2 km/L		
Difference 27%					

Source: Authors calculations

Interestingly, the average fuel economy of highway-tractors has decreased over recent years. Figure 44 compares the results of the 2011 INECC study with those of this more recent 2017 (ICCT) study which shows a 12 percent decrease in fuel economy for the "For Hire" vocation and a 55 percent decrease for Industry and Commerce. It is postulated that this is mainly due to the increased use and loading of doubles and full trailers. In 2011 the "For Hire" fleets included in the survey in 2011 used 1.46 trailers per tractor compared to 1.78 trailers per tractor found in 2017. For Industry and Commerce, the usage of trailers increased from 2.01 to 2.24 trailers per tractor over this six year period (see Table 42)[33].

[33] In addition, it is important to recognize that the 2017 study has a limited size sample, and that part of this apparent difference could be due to differences in the fleets interviewed.



Source: TSTES field studies INECC (2011) and ICCT (2017)

Figure 44 - Fuel Economy of Highway Tractors by vocation in 2017 vs 2011

Table 42 - Ratio of trailers per tractor in the 2011 and 2017 studies

Ratio Trailers/Tractors	For Hire	Industry & Commerce
in 2011	1.46	2.01
in 2017	1.78	2.24

Source: TSTES field studies INECC (2011) and ICCT (2017); see footnote 33

Fuel Cost

At the time of the 2011 survey, the pump price of diesel to all on-road users in Mexico cost around $9.56 MN/L. The average during the 2017 survey was 16.47 MN/L; and increase of 72 percent in 6 years.

Operating Expenses

The operating expenses for highway tractors by expense category and age of vehicle as given by the 44 interviewees are shown in,Figure 45, Figure 46, and Table 43 it can be seen (in Figure 45) that whilst the annual expenditure drops with increasing age (from around 1.7 million pesos over the first 6-8 years of life) to around 1.0 million pesos after 20 years), this is driven primarily by the reduction in annual mileage. Figure 46 in fact shows a slight increase in expenditure per kilometer from around 14 pesos/km over the first 6 – 8 years to almost 16 pesos/km by 15 years of use with a reduction thereafter. Interestingly the shift of expenditures between categories shows a reduction in the cost of the operator

and tolls being offset by an increase in other expense items. Overall, fuel cost comprises 57 percent of expenditure at today's prices, (see

) followed by tolls (21 percent) and operator's salary or fee (9 percent). Note that the cost of purchasing the vehicle is not included in this calculation. Other expense items mentioned by the interviewees are shown in Table 45.

It is interesting to note that the annual operating expenses for those fleets whose business is transport is in general significantly lower than for companies whose business is something else (but use highway tractors in their business). Excluding Operator and Fuel, the For-Hire fleets have the lowest average cost per kilometer ($3.4 MN/km) whilst Industry and Commerce show an average expense of $7.5 MN/km (see Table 44). Significant differences in the expenses by vocation exist. The "For Hire" reports spending more than "Industry and Commerce" in Licenses & taxes, and Insurance; and considerably less in Tolls and Corrective Maintenance. In the author's best judgement, this is due to the different nature of the operations and often due to the owner's or fleet manager's direct level of involvement in these operations.

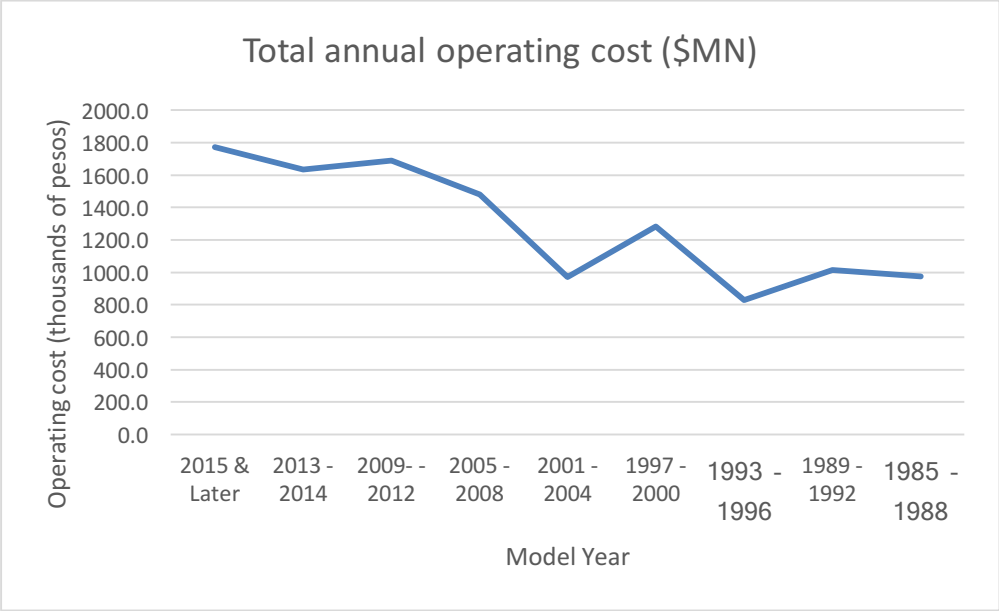


Figure 45 - Total annual operating expenses per unit for Highway Tractors in pesos ($MN)

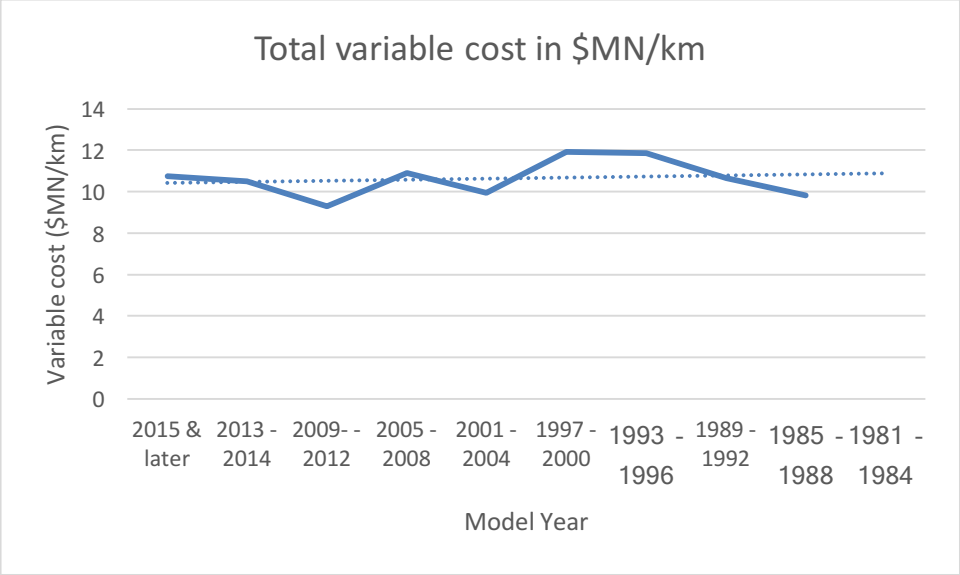


Figure 46 - Total per km operating cost ($MN/km)

Table 43 - Operating Expenses for Highway Tractors (thousands of pesos)

	Fuel	Tolls	Operator	Maintenance		Licenses, taxes	Insur-ance	Tires	Repair	Total
				Corrective	Preventative					
2015 y post	962.5	427.1	176.9	30.9	29.8	54.0	47.0	25.3	21.0	1774.5
2013 - 2014	956.0	348.8	101.2	49.9	60.2	55.8	19.2	23.9	18.8	1633.8
2009- -2012	1033.9	365.7	83.0	76.7	51.5	10.1	21.8	28.9	19.9	1691.5
2005 - 2008	810.4	337.9	109.1	76.6	40.4	26.9	20.9	36.9	20.2	1479.2
2001 - 2004	656.2	27.5	96.7	79.6	28.7	14.6	18.3	29.7	18.5	969.9
1997 - 2000	651.4	50.6	449.5	29.3	23.8	8.5	18.1	42.6	9.5	1283.4
1993 - 1996	612.0	24.5	66.0	57.2	10.8	16.5	18.0	14.9	9.0	828.8
1989 - 1992	821.3	35.3	83.1	8.1	5.0	31.2	6.5	14.3	9.2	1013.9
1985 - 1988	945.7	7.3	10.0	2.7	1.4	2.0	1.7	2.7	0.7	974.1
1981 - 1984	416.8	15.0	0.0	20.0	8.0	15.0	15.0	40.0	20.0	549.8
Average 2017	918.6	335.8	135.7	51.5	42.0	39.2	28.5	27.4	19.1	1597.9
Memo: Averages from the 2011 INECC survey of 180 fleets with 2858 highway tractors										
Average 2011				18.9	13.3		13.1	42.8		

Note: low operator expense on old units reflects the fact that the owner is driving and does not account for his time as an expense item

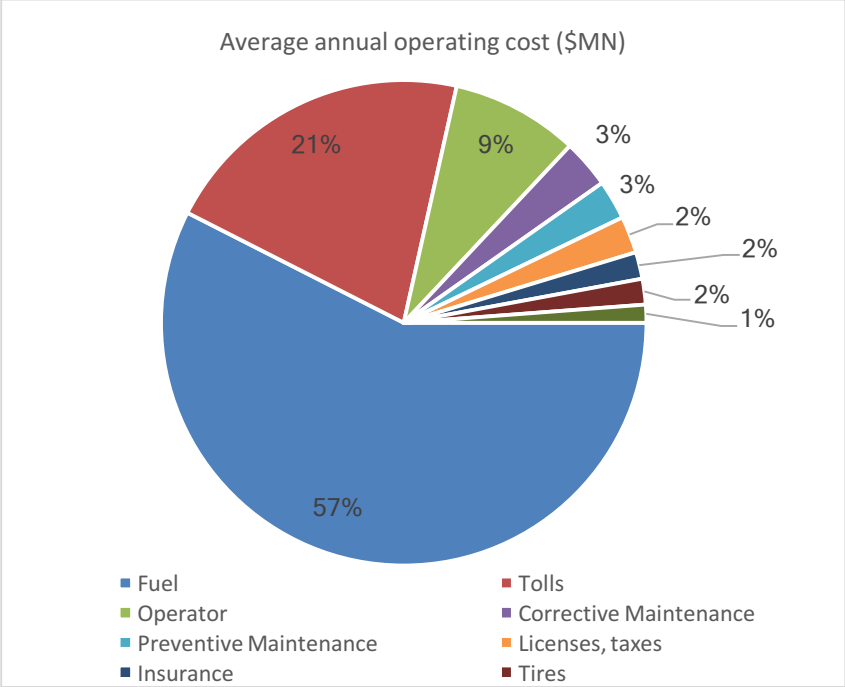


Figure 47 - Percentage distribution of operating expenses

Table 44 – Differences in Operating Expenses for Highway Tractors by Vocation (thousands of pesos)

	Transp	IndCom
Fuel		
Tolls	191.5	539.1
Operator		
Corrective Maintenance	19.3	91.8
Preventive Maintenance	46.8	46.2
Licenses, taxes	71.4	17.6
Insurance	42.5	21.2
Tires	32.1	28.4
Repairs	19.4	22.7
Total	422.9	767.0

Average kms/yr	123,599	102,442
$MN/km	3.4	7.5

Table 45- Other expense items mentioned by the interviewees

Other Expenses
Wheel alignment and Balancing
Credit/Loan payments
Highway rescue after breakdown
Batteries
Parking
Administrative expenses
Diagnostic software
Truck wash
Tank wash and disinfecting
Insurance for semi-trailers
Satellite tracking

Data collected on in-use tractor-trailers in Mexico

The interviewees were asked which agency collects information about vehicles and their use (km / year) in Mexico. Their overall conclusion was sadly that little systematic evidence is collected. SCT does process vehicle registration data but usage data only comes from limited ad-hoc studies commissioned by SCT, CANACAR, CANAPAT, ANTP (Asociación Nacional de Transporte Privado) and SEMARNAT in their "Transporte Limpio" program.

Although a number of entities report some of the information, there is no central database. According to multiple interviewees, including the Ministry of the Environment of the State of Mexico (SMAEM), the entity who should have such database is the Ministry of Communications and Transport (SCT). Carlos Gil Jiménez of SCT asserted that SCT does have a system that allows them to see every registered vehicle with federal license plates, however, as expressed by the Director of Research on Air Quality and Short-lived Climatic Contaminants of INECC, one must be wary of duplication of information.

Preliminary observations performed by INECC has led to believe that SCT's database is closely linked to the sale of trucks, and this relationship has led to duplication as the trucks get registered at the sale and then at the local government level, which then reports to the federal level. Whether it be through a government program or tasked to a ministry, there is a need for increasing the information and knowledge available to both government and transport enterprises.

Transport enterprise should share information regarding their fleet, but should also get information and a guarantee of privacy from government entities. According to SMAEM, what programs currently lack is enough monitoring, and with that, "providing software so that I can know, from my office, if the efficiencies that you are reporting are actually the ones that are occurring".

According to the authorities interviewed, the root of many of the problems in the freight sector in Mexico, in terms of organization, is the lack of regulation and standardization. No one entity collects information on the size and the composition of the freight market or carriers, since there is no effective nation-wide registry. This is made more complicated by the problems associated with a large informal market. There is no official registry of how many freight tons are being transported at the national level. As expressed by Francisco J. Barrera Martínez, "We do not even have a database robust enough to say if there are actually 500,000 tractors circulating around the country, and of those, how many are from Mexico and how many from abroad". Companies tend to misreport and there is little effort to carry out observation and monitoring. The lack of norms and monitoring, ultimately hamper the effectiveness of the Transporte Limpio programs.

The last question was about the controls that the fleet or operator regularly keep. Interestingly only 36 percent of the interviewees reported keeping regular controls and reports on vehicle operation and efficiency (see Table 46). Of the controls mentioned, fuel consumption per vehicle was in first place, followed by vehicle maintenance records and number of trips and mileage per vehicle.

To a far lesser degree were mentioned, operating cost per vehicle, operators, logistics information (particularly tons carried per trip) and records from the engine management computer and GPS.

Table 46 - Which controls do fleets regularly keep?

Controls	%
Fuel consumption	31%
Maintenance	18%
Trips & Mileage per vehicle	15%
Total operating cost	8%
Operators	5%
Logistics, Tons per trip	5%
Telemtry & GPS	5%
Accidents and security	5%
Engine oil optimization	3%
Vehicle speed	3%
Idle time	3%

Memo: the percentage is with respect to the total sample

National Emissions Register (RENE)

The General Law of Climate Change (LGCC) was published on June 6, 2012, and came into force in October of that year. It established the creation of various public policy instruments, including the National Register of Emissions (RENE) and its Regulations, with the objective of compiling the necessary information on the emission of GHG emissions from the different productive sectors of the country.

All companies in the following sectors with annual emissions that exceed 25,000 tCO_2e (tons of CO_2 equivalent) are required to report their direct and indirect emissions[34]:

- Energy
- Industry
- Transport
- Agriculture and fisheries
- Waste, and
- Trade and Services.

This obligatory law is accompanied by a voluntary register (Programa GEI México—see http://www.geimexico.org/) in which over 120 companies are participating.

Amongst the objectives of RENE is to create a robust database of emissions that are verified every three years, and certified to promote the interchange on carbon bonds or sale of carbon certificates.

[34] The greenhouse gases or compounds to be reported are: carbon dioxide, methane, nitrous oxide, black carbon or soot, fluorinated gases, sulfur hexafluoride, nitrogen trifluoride, halogenated ethers, halocarbons, mixtures of these gases and other gases identified by the IPCC and designated by Semarnat.

Chapter 6:- Tariffs, Freight type and Logistics

This chapter compiles information on the interaction between transport (For Hire) fleets and their clients, looking at tariff negotiations, fare increases and trip programming.

Chapter Highlights

Tariff Negotiation and Increases

One third of the surveyed fleets have a fixed contract with their clients; one third negotiate each trip and the remainder have a mix of both-- some clients with fixed contracts and others negotiated per trip.

Of those with a negotiated contract, most negotiate tariff increases yearly based on the 12-month previous inflation, particularly in the cost of diesel. Some said that this negotiation is usually based on tariffs charged by other fleets. 21 percent mentioned that they currently negotiate tariffs on a per trip basis due to the extraordinary increases in fuel costs.

Type and Source of Freight shipments

Whilst bulk freight forms an important part for Agriculture (50 percent) Construction & Mining (40 percent) and Owner-operator (49 percent), only 13 percent of the “For Hire” and 8 percent of “Industry and Commerce” use this mode. Most of the “Industry and Commerce” freight, amongst the interviewees, is palletized (70 percent) follower by cardboard boxes (20 percent). In the “For Hire” vocation the most common load is mixed freight (37 percent) followed by palletized (19 percent).

The source of the shipment for the “For Hire” fleets is primarily traditional clients (55 percent) and fixed contract agreements (16 percent) although freight handlers and independent logistics companies currently represent 19 percent and are growing fast. For the “Industry and Commerce vocation, 40 percent of freight shipments originate in the same company and 30 percent from traditional suppliers. Freight consolidators currently have a 20 percent share of freight origins, amongst the interviewees, in this vocation.

Vehicle loading and scheduling

As far as vehicle loading is concerned, for the “Industry and commerce” vocation, 50 percent of trips are limited by weight, 25 percent limited by volume, and for the remaining 25 percent, the load averages 33 percent of max load and around 67 percent of max volume.

In “For Hire” vocation only 37 percent of trips are limited by weight, 40 percent limited by volume, and for the remaining 23 percent, the load averages 51 percent of max load and around 49 percent of max volume.

The way trips are scheduled also varies by vocation. According to the interviewees, for “Industry and Commerce” in 60 percent of cases the shipment waits until the load is filled, with the remaining 40 percent leaving on time with, or without the complete shipment. In the “For Hire” vocation it is the other way around: 38 percent of the time the shipment waits until the load is filled, with the remaining 62 percent leaving on time with, or without the complete shipment.

Trip programming
In both vocations, most of the trips (56-59 percent) are directly from the supplier to the client. However, 31 percent of “Industry and Commerce” vehicle trips are from the supplier to a warehouse for reshipment, whilst 26 percent of “For Hire” trips are from the warehouse to the end client.
When asked who defines the exact route for the trip, 45 percent of the interviewees said it is the client’s decision, 45 percent said it is only the transport company who decides, with the remainder (10 percent) reporting it as a joint decision.

Fleet membership of associations / confederations
Over half of the interviewees have one or more memberships with associations / confederations / transport organizations. Of these, the most mentioned was CANACAR (46 percent), followed by ANTP (10 percent) and CONATRAM (8 percent). In total 15 associations were mentioned by the interviewees.

Tariff Negotiation and Increases

The interviews were asked how they normally agree contracts with their clients. The response fell into three similarly distributed categories. One third have a pre-negotiated tariff per ton-km or per trip with their clients; one third negotiate each trip and the remainder have a mix of both-- some clients with fixed contracts and others negotiated per trip (see Table 47).

Most of the interviewees (64 percent) negotiate tariff increases yearly, based on the previous 12-month inflation, particularly in the cost of diesel. Some said that this negotiation was based on tariffs charged by other fleets. 21 percent mentioned that they currently negotiate tariffs on a per trip basis due to the extraordinary increases in fuel costs, whilst lower percentages negotiate every 6 months (9 percent); every 3 months or monthly (3 percent each). See Table 48).

Table 47 - Tariff Negotiation

	%
They have fixed contracts with clients	32%
They negotiate contracts for each trip	32%
Both of the above: some clients with fixed contracts and others negotiated per trip	35%

Table 48 - Frequency of Tariff Increases

	%
Annual	64%
6 month	9%
3 month	3%
monthly	3%
per trip	21%

Many of the transport companies interviewed expressed that the contracts between transport companies and their clients are very much in favor of the latter because “if you arrive late, you are penalized, if you are robbed, worse, and if you crash, you pay. Unfortunately, the contract is normally written up by the client and we just sign it”.

Transport companies, as any other service, must increase the prices from time to time as the costs of operation go up and as the price of diesel changes. If diesel were to increase 6 percent, a transport company may look to increase the price of the service by a similar percentage (since fuel accounts for approximately 60 percent of their costs. However, many times, the increase in operation costs are not fully reflected in the renegotiated contracts, forcing companies to look for cost-saving measures. According to multiple interviewees, the danger of losing clients over price increase is high. Clients may look to negotiate lower freight increases by offering higher volumes of cargo, however, For Hire companies, and particularly owner-operators, know that if they don’t accept the terms, the client will contract a provider with a lower quote.

Type and Source of Freight shipments

The type of cargo moved by companies largely depends on the vocattion they participate in. Bulk freight is predominant in Agriculture (50 percent) Construction & Mining (40 percent) and Owner-operator (49 percent), For product-oriented companies like the "Industry and Commerce", the type of cargo is dominated by palletized and cardboard boxes; whereas the mixed cargo plays a more prominent role in the "For Hire" caregory, reflectiung the more diversifiued activity for this type of carriers.

The source of the shipment also varies by vocation. The “For Hire” fleets primarily pick-up from what they consider to be their traditional clients (55 percent) being those that they have served for a number of years. Fleets classify seperatly the fixed contract agreements (16 percent) that they have negotiated

and won from other clients and the business obtained from freight handlers and independent logistics companies which currently represents 19 percent of shipments and is growing fast (seeFigure 49).

For the “Industry and Commerce vocation, 40 percent of freight shipments originate in the same company and 30 percent from traditional suppliers. Freight consolidators currently have a 20 percent share of freight origins, amongst the interviewees, in this vocation.

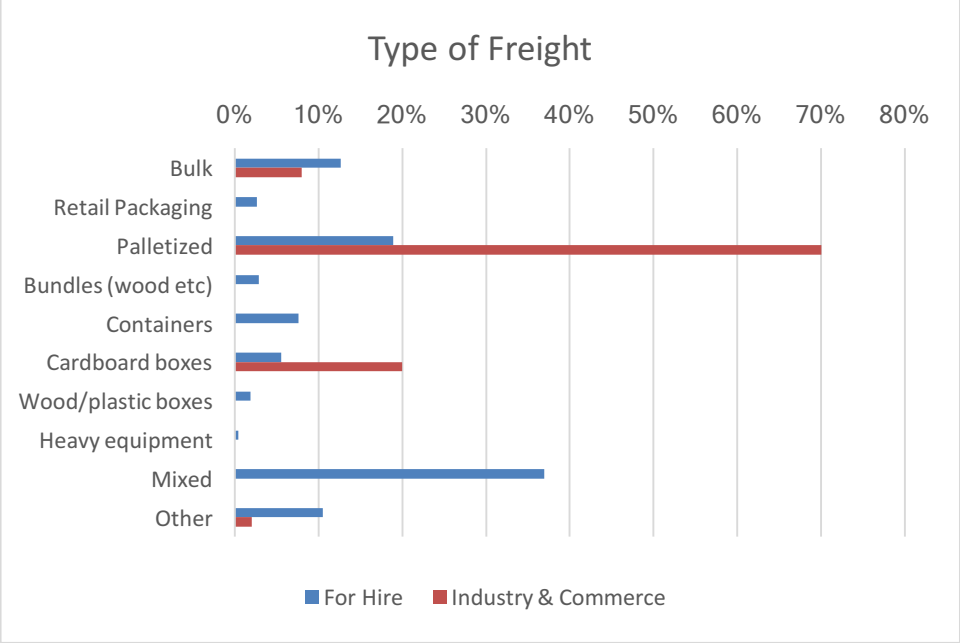


Figure 48 - Type of freight by vocation

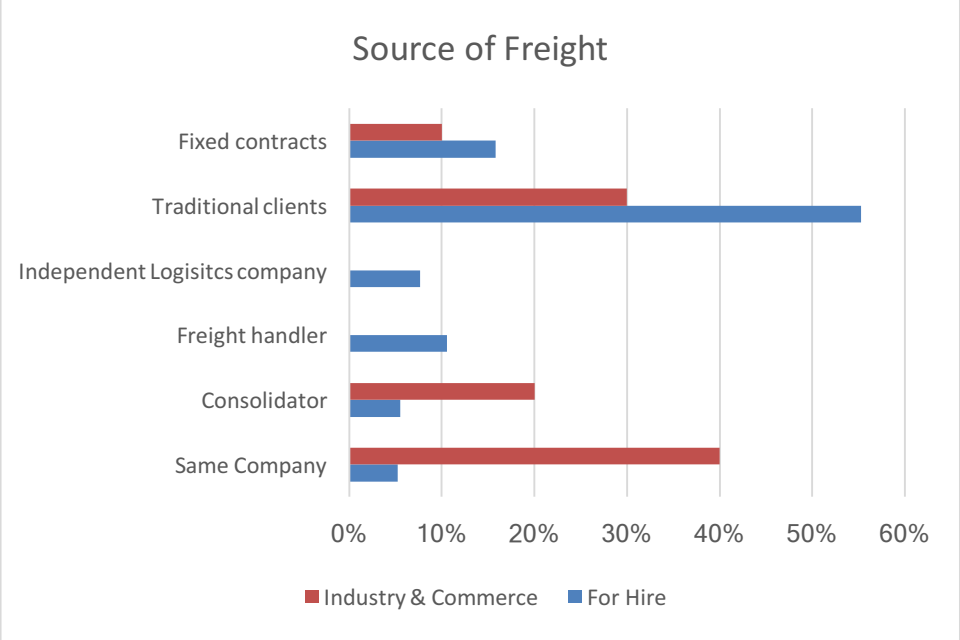


Figure 49 - Source of Freight

Vehicle loading and scheduling

In the “Industry and commerce” vocation, freight shipment is but one step in their productive process and this greater control allows a more complete uuse of the freight capacity. For this vocation, 50 percent of trips are limited by weight, 25 percent limited by volume, and for the remaining 25 percent, the load averages 33 of max load whilst the volume is around 67 percent of max volume (see Figure 50). Additionally, according to the interviewees, in 60 percent of cases the shipment waits until the load is filled, with the remaining 40 percent leaving on time with, or without the complete shipment (see Figure 51).

In the “For Hire” vocation the converse is true: 38 percent of the time the shipment waits until the load is filled, with the remaining 62 percent leaving on time with, or without the complete shipment. This results in lower average loading. Here only 37 percent of trips are limited by weight, 40 percent limited by volume, and for the remaining 23 percent, the load averages 51 of max load whilst the volume is around 49 percent of max volume

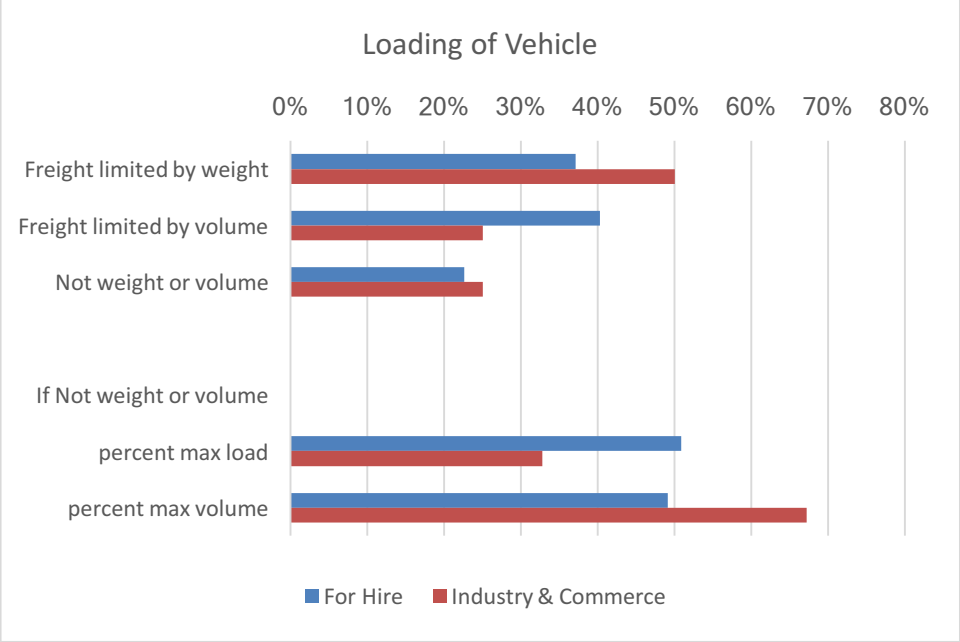


Figure 50 - Loading of Vehicle

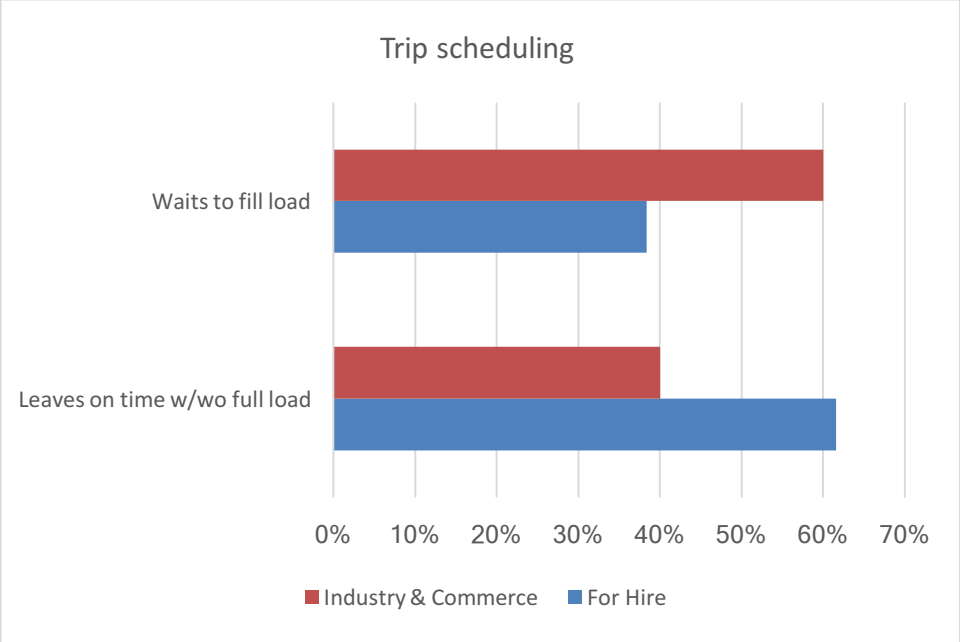


Figure 51 - Trip scheduling

Logistics

In both vocations, most of the trips (56-59 percent) are directly from the supplier to the client. However, 31 percent of "Industry and Commerce" vehicle trips are from the supplier to a warehouse for reshipment, whilst 26 percent of "For Hire" trips are from the warehouse to the end client (see Figure 52).

For Hire fleets interviewed said to have noticed a strong trend towards an increasing number of distribution centers, mainly due to cargo regulations and growth of the urban areas. It is increasingly difficult to haul through densely populated areas. Therefore, freight companies find themselves dividing the cargo into smaller quantities and vehicles as they approach the urban cores. As one transport company noted "It will be progressively more difficult to enter Mexico City with a bulk carrier or gondola. It is very difficult, because the client does not have the infrastructure to receive a truck of such dimensions. This forces the fleet to consider delivering split loads on smaller trucks. However, it is not always easy to reach a distribution center, unload, dispatch that product, and then start distributing it on a smaller vehicle, because this can provoke loss of merchandise, increased pollution, and loss of time. Owner-operators often operate with "consolidated loads", therefore the role of their fleet in the process is slightly different. Unlike bigger fleets, Owner-operators tend not to directly haul products to the final destination or into distribution centers. The smaller fleets collect products using small, old trucks which they use for the short trips to the consolidation center. Once in the consolidation center, the products are transferred to the large transport enterprises, who then proceed to haul the products in large trucks to the distribution centers.

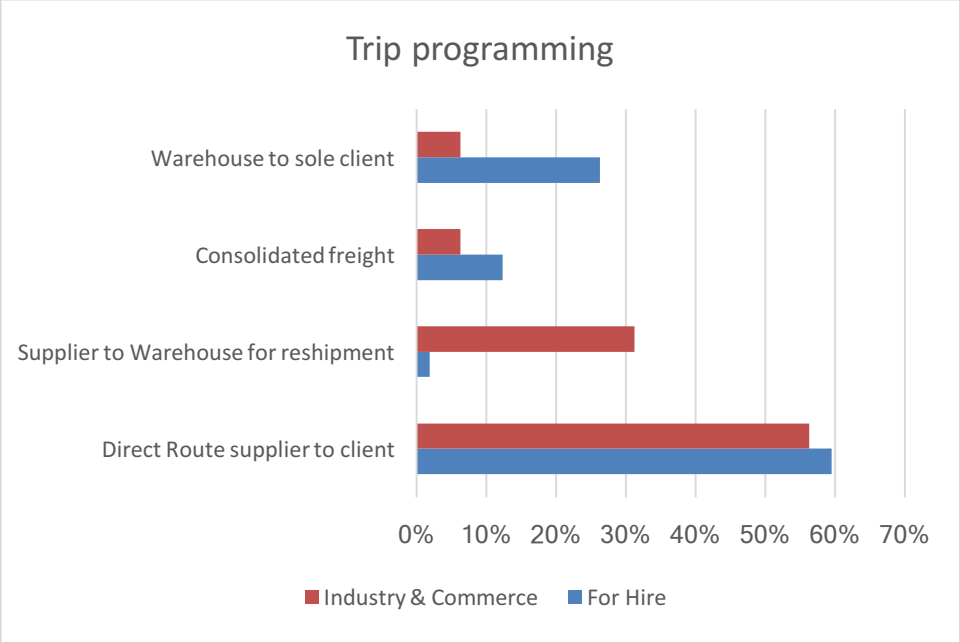


Figure 52 - Trip programming

When asked who defines the exact route for the trip, 45 percent of the interviewees said it is the client's decision, 45 percent said it is only the transport company who decides, with the remainder (10 percent) reporting it as a joint decision (see Table 49). The internal areas of the transport company involved in making this decision are in descending order of incidence; Operations, Sales & marketing, Logistics and Shipping. However, the exact departure time is more often defined by the client (in 62 percent of the cases) and very little joint decision process is used here.

Table 49 - Who defines the exact route and departure time

	Who defines the exact route	Who defines the exact departure time
	%	%
Client	45%	62%
Transport company	45%	36%
Both together	10%	2%

Fleet membership of associations / confederations

Fifty-five percent of the interviewees have one or more memberships with associations / confederations / transport organizations. Of these, the most mentioned was CANACAR (46 percent), followed by ANTP (10 percent) and CONATRAM (8 percent). In total 15 associations were mentioned by the interviewees (see Table 50).

Table 50 - Memberships with associations / confederations / transport organizations

	Associations / confederations / transport organizations	%
CANACAR	Camera Nacional del Autotransporte de Carga	46%
ANTP	Asociación Nacional del Transporte Privado	10%
CONATRAM	Confederación Nacional de Transportistas Mexicanos	8%
ANIQ	Asociación Nacional de la Industria Química	5%
CONCAMIN	Confederación de Cámaras Industriales	5%
AMMPAC	Asociación Mexicana de Mensajería y Paquetería A.C.	3%
BASC	Business Alliance for Secure Commerce	3%
CANACINTRA	Cámara Nacional de la Industria de Transformación	3%
CANACO	La Cámara Nacional de Comercio, Servicios y Turismo	3%
CCE	Consejo Coordinador Empresarial	3%
CESPEDES	Consejo Empresarial para el Desarrollo Sostenible, WBCSD por sus siglas en inglés (World Business Council for Sustainable Development)	3%
C-TPAT	The Customs-Trade Partnership Against Terrorism	3%
CAINTRA	Comité de Transporte de la Cámara de la Industria de Transformación de Nuevo León	3%
CCNN-TT	Comité Consultivo Nacional de Normalización de Transporte Terrestre	3%
TMC de México	Techonology and Maintenance Council Mexico	3%

Chapter 7:- Institutional and Regulatory Framework

This chapter compiles information on the institutional and regulatory framework that surrounds on-road freight transport in Mexico.

Chapter Highlights

Regulation and enforcement
Commercial freight transport in Mexico was deregulated between 1989 and 1993. This deregulation was complimented by certain restrictions and requirements providing sufficient barriers to entry to ensure financial and safety standards.
Many new operators entered the market in the '90s and a World Bank case study found that within 5 years road transport prices had fallen by 23 percent in mainly the lower quality-of-service segments, which tended to be the owner-operators who shipped lower value, high volume products, whilst the price that customers shipping higher value and time sensitive goods were willing to pay was found not to have fallen by much.
The regulator of road transportation is the SCT, through the General Direction of Federal Road Transport (DGAF) through 4 federal laws and several official standards (NOM). SCT together with the police also have the responsibility for enforcement.

Policies that effect on-road transport (current and future)
Both private and public sectors, concur that many current policies and program do not go the lengths needed to produce meaningful impact. They agree that new laws or norms should be implemented to limit the age of the vehicles that circulate on federal roads and promote efficiency in the industry and the growth of clean freight.
Opportunities include programs and policies that:

- encourage changes in the approach to vehicle maintenance policies,
- allow Socially Responsible Companies to have a competitive advantage in terms of business opportunities
- promote comprehensive fleet management systems
- help establish systematic planning and control of routes and increase integration of the transport fleet into the supply chain; and
- Assist in training, motivation and continuous retention of staff

Impact of Deregulation

Commercial freight transport in Mexico was deregulated between 1989 and 1993, with a market oriented approach adopted over the previous system of licensing each operator to provide freight

services. This deregulation was complimented by certain restrictions and requirements providing sufficient barriers to entry to ensure financial and safety standards.

Many new operators entered the market in 1990 and a World Bank case study found that within 5 years road transport prices fell by 23 percent.[35] The greatest declines occurred in the lower quality-of-service segments, commonly served by owner-operators, who shipped lower value and high volume products. Meanwhile, customers' willingness to pay for shipping higher value and time-sensitive goods did not fall as much.

Present Regulation

The regulator of road transportation is SCT, through the General Direction of Federal Road Transport (DGAF). The legal framework consists principally of the following regulations[36]:

- Federal Law on Roads, Bridges and Motorized Transport (Ley Federal de Camionos, Puentes y Autotransporte Federal, LCPAF)
- Law of General Communication Routes (Ley General de Vias de Communicacion, LGVC)
- Law of Public-Private Associations (Ley de Asociaciones Publico Prividas, LAPP)
- Federal Law to Control Chemicals Precursors, Essential Chemical Products and Machines to Elaborate Capsules, Pills and Tablets (Ley Federal para el Control de Precursores Quimicos, Productos Químicos Esenciales y Máquinas para Elaborar Cápsulas, Tabletas y Comprimidos, LGCPQ)

Some of these laws are supported by specific by-laws and NOMs. The most important of these specify vehicle dimensions permitted to operate and vehicle equipment requirements.

The OECD review of Regulation of Freight Transport in Mexico (2017) highlighted certain gaps in the regulations, the most notable being lack of driving and rest time regulations to avoid driver fatigue.

Regulations regarding the type and minimum standard of vehicle permitted to be imported and first registered in Mexico are also set out in the NOMs. The large number of second hand imported vehicles makes the application and enforcement of the safety and environmental standards set out in the NOMS particularly important.

NOM-044 of SEMARNAT establishes the maximum permissible limits regarding vehicle emissions. This regulation is currently under revision, with the foreseen improvements in fuel quality allowing more stringent emissions standards to be applied.

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[35] Source: Dutz, Hayri and Ibarra (2000), Regulatory Reform, Competition and Innovation: A Case Study of the Mexican National Competition Agency Road Freight Industry, https://openknowledge.worldbank.org/bitstream/handle/10986/22187/WPS2318.pdf?sequence=2&isAllowed=y

[36] Review of the Regulation of Freight Transport in Mexico, OECD 2017

Required Documentation and applicable standards

Freight transport in Mexico requires the operator/vehicle to have a number of documents in order.

Operator

1. Federal driving License; normally Type “B” or Type “E” for hazardous freight.
2. Proof of Psychophysical Aptitude, (current).
3. Non-penal background check
4. Log of hours of service of the driver. (this is a requirement that was not mentioned by the interviewees)

All Vehicles

1. Valid circulation card for highway tractor.
2. License Plates and sticker for highway tractor.
3. Third Party Damage Insurance Policy, (Civil Liability Insurance for 19,000 days of Minimum wage in force in the Federal District. This equates to approximately US$85,000)
4. Certificate of low emission of pollutants, in force.
5. Certificate of physical and mechanical conditions (In compliance with NOM-068-SCT-2-2000.
6. Valid circulation card for the semi-trailer and the trailer.
7. Metal identification plate issued by the SCT for the semi-trailer and the trailer
8. Permits for connectivity routes (between highways of a higher weight class
9. Permits for local operation, to enter cities like Celaya, Aguascalientes, Guadalajara
10. Permits to operate in restricted zones

Additional requirements for hazardous freight

11. Ecological damage insurance policy, (Environmental damage insurance for $ 900,000.00 This equates to approximately US$50,000)).
12. Document of shipment of the transported product.
13. Format of "Emergency transportation information", indicating the actions to be taken in the event of an accident occurring, according to the hazardous material or waste concerned.
14. Daily technical visual inspection format of the unit.
15. Manifest of delivery transport and reception, for the case of transportation of hazardous waste, issued by the Secretariat of Social Development
16. Authorization for the case of import and export of hazardous materials,
17. Manifest for cases of spills of hazardous waste by accident.
18. Documental proof of tank cleaning. Cleaning is only obligatory for reasons of incompatibility of the products to be transported.
19. Signage indicating the United Nations number of the transported product, as well as the classification of the product.

20. Emergency telephones in case of accident and / or spill: SETIQ: 01-800-00-214-00, in The Mexican Republic, 55591588, for the City of Mexico and Metropolitan Area. CENACOM: 01-800-00-413-00, in the Mexican Republic. 5550-1496 or 5550-1552, for the City of Mexico and Metropolitan Area.
21. Emergency equipment (medicine cabinet, extinguishers and the one indicated in the emergency sheet).

Main Standards and regulations that should be met by transport vehicles

NOM-012-SCT-2: Weight and maximum dimensions for vehicles that transit in federal highways

Table 51 - Weight and Dimensions

Vehicle Classification	Configuration	Number of axles	Number of tires		Road Classification				
					ET & A+	ET & A	B	C	D
T3-S2		5	18	Max GCW (t)	46.5	41.5	38.0	33.5	NA
				Max Length (m)	23.0		20.8	18.5	NA
T3-S3		6	22	Max GCW (t)	54.0	48.0	45.5	40.0	NA
				Max Length (m)	23.0		20.8	18.5	NA
T3-S2-R4		9	34	Max GCW (t)	75.5	66.5	66.0	NA	NA
				Max Length (m)	31.0		28.5	NA	NA

Sourc: SCT Note: "ET and A +".-The maximum gross vehicle weight authorized for vehicles and vehicle configurations may be increased when traveling on ET and A roads with no connectivity. NA - Not Authorized

NOM-068-SCT-2-2014: Physical-mechanical and safety inspection of vehicles. Establishes the physical and mechanical safety requirements for vehicles, whilst NOM-035 sets out the requirements for trailers, semi-trailers and converters.

NOM-040-SCT-2: For the transport of indivisible objects, of great weight and / or volume by roads and bridges of federal jurisdiction.

NOM-045-semarnat-2006: Vehicles in circulation that use diesel as fuel. Maximum permissible limits of opacity, test procedure and technical characteristics of the measuring equipment.

NOM-EM-167-Semarnat-2016: Establishes emission levels of pollutants for motor vehicles circulating in Mexico City, Hidalgo, State of Mexico, Morelos, Puebla and Tlaxcala; The test methods for the certification of said levels and the specifications of the equipment used for such certification.

Enforcement: Heavy vehicle licensing and operating regulations compliance is the responsibility of police and SCT inspectors. Compliance activities includes road-checks and visits to companies. There are 70 roadside weighing stations to test for vehicle overloading nationally.

On-road transport policies (current and future)

Interviewees, from private and public sectors, concur that many current policies and programs fail to produce a meaningful impact. As expressed by Judith Trujillo Machado from SEMARNAT, "for several years we have been aware that we must implement some type of new laws or norms, such as limiting the age of the vehicles that circulate on federal roads. However, this has not gained any traction. Current financing, scrapping, and other programs are not doing enough". An idea proposed, with support from multiple transport fleets interviewed, beyond recognizing clean fleets with some kind of certificate, is to reward such fleets by providing them with competitive advantages. One possible benefit could be permitting access to certain urban markets only to those fleets who comply with environmental standards. Limiting 'dirty' fleets' access into urban centers would be a transformative driver for enterprises to change practices and adopt cleaner technologies.

Another opportunity for policy improvement mentioned by interviewees is the increase of some subsidies and the reduction of others affecting the sector negatively. According to foreign investment laws, foreign companies cannot haul inter-state freight in Mexico. This is meant to protect the Mexican freight sector from being over-run by the financial strength of American transport enterprises. However, according to multiple interviewees, the law is redacted in such way that it hampers Mexican fleets. The law states that Mexican companies with foreign investment (private transport companies) may only haul their own merchandise. The outcome of such norm is that once the fleet has unloaded its merchandise, the return trip is done with an empty truck, since it can only haul its own products. There is a subsidy attached to this norm, essentially paying private transport enterprises to return empty. Professional companies in Mexico cannot dedicate part of their resources to federal public transport, because the law is poorly worded. According to Ing. Alex Theissen Long of FEMSA Logistics "The subsidy that exists allows you to remain mediocre, since you get paid for it. It is a subsidy that must disappear because, on top of everything, it generates free pollution". This situation is causing explosive growth amongst 3PLs as a way around this law. By shifting their fleet to a 3PL, Coca Cola said that they can now carry bottled water from a sister company on their return trips, something that they had been restricted from doing. Allowing private companies to haul freight from other private companies on return trips could be a cost-effective and efficiency-inducing measure. Another policy that requires revision, based on the comments by the transport enterprises interviewed, is the certification of tank-truck-washing stations. The cost associated with complying with the standards necessary for certification, make truck-washing stations economically unsustainable. The costs result in having few certified washing stations which in turn leads in inefficiencies in the service due to delays. As one of the transporters stated "thankfully, no one has been able to fully comply with all the requirements. If someone were to be able to, we all have to be careful. Because of that one, we would all get fined a hefty amount, while still not be able to comply ourselves". Although the goal of the policy ultimately is to increase the standard in the transport of delicate cargo such as comestibles, the current policy is proving to be too costly.

A policy proposed by the interviewees, in this case INECC, is to exempt enterprises participating in programs such as Transporte Limpio from having to go through vehicle emissions testing. Regardless of

the types of policies that need to be implemented, as part of any future norms, there must be better monitoring and more professional, constant reporting from transport enterprises, something they are willing to do if the information is kept confidential and there is increased support from the government.

Opportunities for a policy framework to promote the growth of clean freight

When question on the needs and opportunities for a policy framework to promote the growth of clean freight in Mexico, transport fleets of varying sizes agreed on the following:

1. Government entities would benefit from encouraging changes in the approach to vehicle maintenance policies, encouraging companies towards preventive and predictive practices. This is a problem specially among smaller transport fleets as many times they lack financial capability or foresight to see the benefits of proper maintenance. This shift in fleet maintenance practices are part of what SEMARNAT call the professionalization of transport fleets. According to the deputy director of the transport sector at SEMARNAT, "There is still a lag in this whole issue of the professionalization of companies. If we start to do it, we will have many benefits, because that has a direct effect on aspects from fuel consumption to using and maintaining the correct parts of the trucks according to their use".
2. The government could also create policies that allow Socially Responsible Companies to have a competitive advantage in terms of business opportunities. Every entity interviewed declared that the current incentives were not enough and that only more, newer, and more tangible incentives will bring fleets on board clean transport programs. On the topic, SMAEM said of transport companies of all sizes "they want to save, but they also have to invest. In order to be able to invest, they have to be given all types of incentives; tax incentives, import incentives, even giving them a special discount or price when they reach industrial corridors". As part of those incentives, there must be financing systems to help fleets cope with the capital costs of participating in programs that would certify them as socially responsible companies.
3. Establish a comprehensive fleet management system in addition to standardization of vehicles and spare parts available according to the type of operation. An important step toward achieving a comprehensive fleet management would be to implement vehicle tracking and communication systems. Transportation management can help fill the gaps when trucks are not at full capacity, and also optimize the load of truck that are at full capacity.
4. Establish a system of planning and control of routes, increase integration of transport fleet into the supply chain, and establish logical processes of loading and unloading box trailers. Logistics companies are currently seen by many as too expensive for a large portion of the freight sector in Mexico, however, both big and small companies have seen the value of logistics as they are an integral part of successful transportation in both the United States and Canada. The current process is slow and results in inefficiencies in terms of time as well as inefficiencies in terms or merchandise lost or damaged. Based on the comments from multiple transport fleets, the supply change is

not fully integrated yet. There are instances where the final destination is not ready or capable of handling the cargo as it arrives, creating costly lost time. As indicated by Francisco J. Barrera Martínez of SMAEM, "transport fleets want to see a multifunctional process where technology and mobility go hand-in-hand and where cities help the process of heavy duty vehicles arriving to the loading and unloading docks".

5. Training, motivation, and continuous retention of staff. During the interviews, one transport fleet declared "I insist that training staff, measuring the effectiveness of this training and taking advantage of new vehicular technologies will help us a lot". That transport company was not alone in their assertion. Multiple interviewees expressed their desire for increased focus on training for operators and other staff. Frequently, there is a fear staff will leave after a company had invested resources into their training, however, the consequences of untrained staff outweigh the risk of having the individual leave. These negative consequences can be more clearly seen among small fleets and owner-operators who suffer from costly inefficiencies that are not tied to the choice of technology. Proper training and education can not only lead to economic benefits, but also lead to environmental benefits and road safety.
6. All interviewees agreed that the move towards greening freight is hampered by the generally poor condition of Mexican highways and transit security. The poor conditions of the routes make the transport less efficient, as compared to similar units in other countries. Many of the small enterprises do not make use of the correct tires or correct maintenance, which, exasperated by overloading, further increases the negative impact of the roads on the state of freight in Mexico. In terms of security, a small enterprise, with little to no financial capabilities, is further deterred from investing in efficiency-improving accessories by the risk of having those components stolen before the full return on investment.

According to multiple interviewees, there are some essential differences between the large transport fleets and the small transport fleets. Comprehensive fleet management would increase the standard of service and make small companies more professional and competitive by tackling the following essential differences:

- the frequency of new vehicle purchases,
- the knowledge of technological needs according to the use of each truck unit,
- operational and energy costs,
- availability of units,
- the drivers' level of training in environmental and road driving education,
- number of drivers available for long trips without stops to reduce risk in transportation of perishables,
- capacity of negotiation for the acquisition of units and spare parts in large volumes,
- strictness and controlled compliance in periods of maintenance of the vehicle,
- systems for operations control, monitoring and security of the load while on the road; and
- adherence to norms and environmental conscience.

Each of these differences represent both challenges and opportunities for the freight sector in Mexico. If addressed properly, those opportunities will positively disrupt the sector, bolstering its growth and increasing its international competitiveness.

Chapter 8:- Programa de Transporte Limpio and related programs

This chapter compiles information on standards and programs in Mexico that promote clean transport—such as the Programa de Transporte Limpio—and look to modernize the vehicle fleet.

Chapter Highlights

Current policies and programs
There are at present three governmental programs in Mexico which aim to promote efficiency and environmental performance in the trucking sector: The Clean Transportation Program (Transporte Limpio), the Program for the Modernization of the Federal Motor Carrier Fleet and the Federal Motor Carrier Scrappage Scheme.

Transporte Limpio
Transporte Limpio is a voluntary program developed by the Secretariat of Environment and Natural Resources (SEMARNAT) and the Secretariat of Communications and Transport (SCT). Transporte Limpio aims to help federal motor carrier permit holders (freight carriers and users) to reduce their fuel consumption, GHG emissions and criteria pollutants and their operating costs through the adoption of strategies, best practices and technologies. SEMARNAT reports that since 2008, the program has led to the mitigation of 5.3 million tonnes of CO2, with significant reductions in fuel usage across the freight sector.
Although Transporte Limpio has made progress, there are several key challenges and barriers which prevent the program from being more effective:

- Limited budget and outreach
- Consolidation and scope
- Marketing
- Financing
- Regulatory Issues
- Technology evaluation

There are several areas that offer considerable potential to strengthen the program:

- Leverage of the future emissions standard NOM-044
- Increase marketing and awareness
- Improve data collection and recovery
- Increase financing options for carriers
- Improve links between Transporte Limpio and Fleet Modernisation and Scrappage programs
- Further homologation with SmartWay

Program for the Modernisation of the Federal Motor Carrier Fleet
The Program for the Modernisation of the Federal Motor Carrier Fleet has been developed and promoted by the SCT and NAFIN. The program provides funding and tax incentives for the acquisition of more efficient and lower emission vehicles, which are new or nearly new (up to 6 years old). To increase the distribution of credit and thus encourage the renewal of more units, Federal Government provides support to interested financial intermediaries. As of 2012, approximately 48,019 lower emission vehicles have been financed under the scheme.

The biggest challenge associated with this program is the inability for small carriers and owner-operators to meet credit requirements. Due to seasonal cash flows amongst smaller carriers, this often leads to them not meeting requirements. Further, the requirements for credit stability are often considered unachievable and expensive, such as documentary evidence of economic solvency.

Federal Motor Carrier Scrappage Scheme
The Mexican Scrappage Scheme is operated again by Mexican government, and promotes the replacement of old trucks (over 10 years old) with incentives towards their scrappage, with the maximum incentive being approximately 15 percent of the value of a new unit. Between 2004 and 2014, more than 22,000 trucks have been scrapped, and approximately 1.5 million tons of CO2 has been mitigated. In May 2015, the scheme was updated, bringing the maximum financial incentive to approximately $250,000 MXN.

The challenges faced under the scrappage scheme are linked closely to that of the fleet renewal scheme, largely due to a lack of funding within the program. This has led to incentives often being below value of old unit leading to operators selling their old units rather than scrapping. Additionally, the lack of lineage between the Fleet Modernization Program has led to more vehicles entering the fleet than being scrapped.

Future policies and programs
Mexican Official Standard NOM-044
The new version of NOM-044 was expected to enter as from Jan,1, 2019 but has been delayed principally due to the necessity of nationwide availability of ultra-low sulfur diesel fuel, needed for EPA 2010/Euro 6 vehicles, superseding the current Euro 2/3 standard. The update basically states that from 1 January 2019, limits equivalent to EURO VI / EPA 2010 must be met. However, EURO IV / EPA 2004 vehicles will still be allowed to be marketed for six months after that date and vehicles that comply with limits equivalent to EURO V may be marketed for two years (until 1 January 2021).
In parallel, Mexico also intends to develop an energy efficiency standard for heavy vehicles related to the new US requirements that are currently in flux.

Federal Road Freight Transport NAMA (for owner operators and smaller fleet carriers) The Federal Road Freight Transport NAMA (Nationally appropriate mitigation action) is a program currently being developed under the Mexican-German NAMA Program. The main aim of the NAMA is to improve the energy efficiency of the Road transport sector through measures similar to the current federal suite of programs, focusing largely on owner operators (up to 5 vehicles) and small fleet carriers (up to 30 vehicles).

Current policies and programs

There are at present three governmental programs in Mexico which aim to promote efficiency and environmental performance in the trucking sector: The Clean Transportation Program (Transporte Limpio), the Program for the Modernization of the Federal Motor Carrier Fleet and the Federal Motor Carrier Scrappage Scheme.

Transporte Limpio

Transporte Limpio is a voluntary program developed by the Secretariat of Environment and Natural Resources (SEMARNAT) and the Secretariat of Communications and Transport (SCT). Transporte Limpio is modelled after the USA's Environmental Protection Agency (EPA) SmartWay program.

Transporte Limpio aims to help federal motor carrier permit holders (freight carriers and users) to reduce their fuel consumption, GHG emissions and criteria pollutants, and their operating costs through the adoption of strategies, best practices, and technologies[37] .

Purpose of Transporte Limpio

The program provides recognition for carrier's participation, especially those implementing plans and meeting fuel saving targets. More importantly, the program enables data collection to better understand the current status of the carrier's fleet. This measurement leads the transport fleet to make decisions, to evaluate fuel consumption, routes, operators, and handling. The information collected through Transporte Limpio informs the truck selection process and their suitability for the expected duty cycle and route, by evaluating specific characteristics such as the torque, differential pitch, transmission and wheel or tire size. The program promotes the fleet to make these measurements and improve its fuel consumption, under its own type of operation and routes.

[37] SEMARNAT, 2015http://www.semarnat.gob.mx/temas/gestion-ambiental/calidad-del-aire/transporte-limpio

Program achievements

Since 2008, it is estimated that the program has led to the mitigation of 5.3 million tons of CO_2 through the participation of 334 companies with approximately 19,000 vehicles, accounting for approximately 4 percent of the total Mexican road freight fleet[38]. This reported saving equates to slightly over 500 million gallons (≈1900 million liters) of diesel fuel.

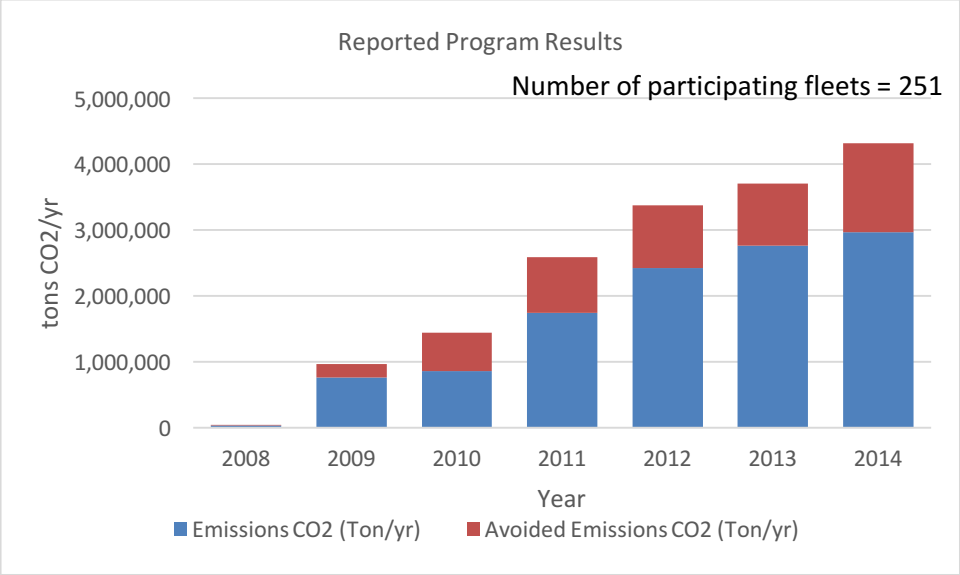
Table 52 outlines some of the strategies and technologies being promoted by Transporte Limpio, including projected fuel savings (percent), whilst Figure 53 shows the carbon emissions mitigation achieved by Transporte Limpio between 2008 and 2014.

Table *52* - Transporte Limpio marketed fuel savings from strategies and technology

	Measure	Potential for fuel economy
Strategies	Training operators how to drive technical-economically	10-30%
	Speed regulation	5-15%
	Reduce idling	Minimum 5%
	Vehicle selection and specification	Variable up to 30%
	Maintenance	7-15%
	Logistics	Variable, at least 10%
	Fuel control	Minimum 5%
Technologies	Aerodynamic improvements	5-10%
	Low resistance road surfaces	3%
	Automatic tire inflation systems	1%
	More advanced lubricants	1.5%
	Emission control devices	

Source: SEMARNAT https://www.gob.mx/semarnat/acciones-y-programas/programa-de-transporte-limpio-26305

[38] SEMARNAT/DGGCARETC, 2017, https://www.gob.mx/semarnat/acciones-y-programas/programa-de-transporte-limpio-26305



Source: SEMARNAT Informe Mensual Transporte Limpio. Información actualizada al mes de diciembre de 2015

Figure 53 - Carbon emissions savings resulting from Transporte Limpio (2008 to 2014)[39]

Effectiveness of the program from the fleets' perspective

We asked fleets about their knowledge of, and participation in, the Programa de Transporte Limpio (Figure 54). Sixty one percent knew of the program and 41 percent said that they participate actively in the program. Almost all of those that know of the program measure in some way their progress. However, whilst 9 percent say they monitor weekly or more often and 30 percent monitor monthly, the majority (56 percent) do not review more frequently than every semester (see Table 53).

Almost all of those that know of the program have made changes to improve the performance and emissions of their vehicles (Table 54). The changes most commonly cited include (Table 55):

- Fleet renewal: vehicle specs chosen to optimize fuel economy for specific routes (21 percent)
- Improved maintenance program (19 percent)
- Mechanical improvements, engine reprogramming to reduce idle time and limit top speed (16 percent)
- Operator training (9 percent) was rather surprisingly in 4th place.

Changes that they plan to make over the rest of this year include basically an extension of what they are currently doing (see Table 56).

[39] This graph, published in 2015, shows avoided emissions, accumulated from 2008 to 2014 of 4.9 million tons CO2 with a participation of 251 companies. According to their 2017 report, the avoided emissions from 2008 to 2016 totaled 5.3 million tons CO2 with a participation of 334 companies.

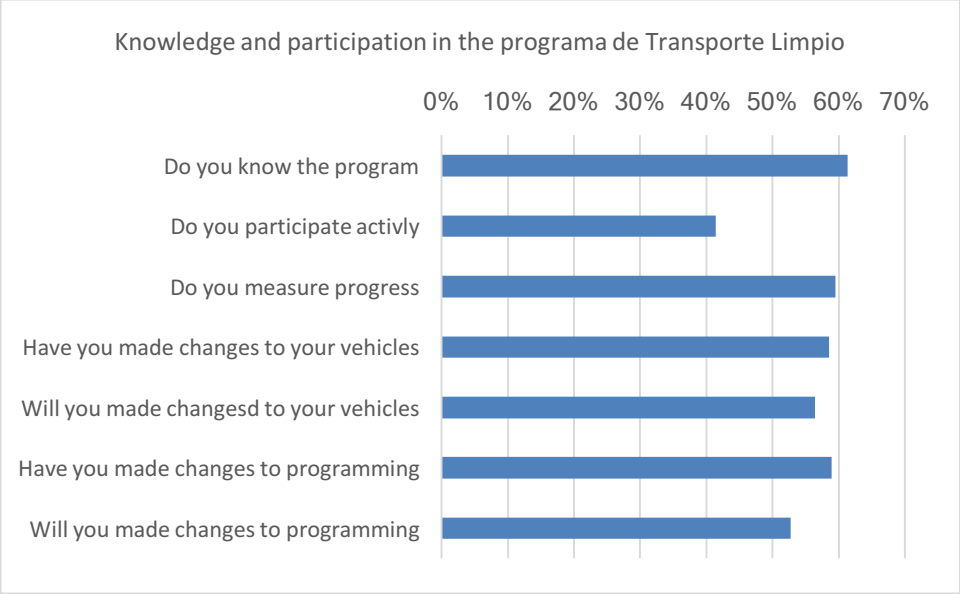


Figure 54 - Knowledge and participation in the Programa de Transporte Limpio

Table 53 - How often do you measure progress?

Frequency	%
Annually	39%
every 6 months	17%
every 2 months	4%
monthly	30%
weekly or more often	9%

Table 54 - Have you made changes to improve the performance and emissions of your vehicles? Which?

Frequency	%
Fleet renewal: vehicle specs chosen to optimize fuel economy for specific routes	21%
Improved maintenance program	19%
Mechanical improvements, engine reprogramming	16%
Operator training	9%
Improved per unit data and control	9%
Improved aerodynamics	7%
Auto-inflation	5%
Synthetic oil	5%
More efficient engines	5%
Wide-double tires	2%
reduce fuel leaks	2%

Table 55 - Changes made to improve the performance and emissions of their vehicles

Frequency	%
Fleet renewal: vehicle specs chosen to optimize fuel economy for specific routes	21%
Improved maintenance program	19%
Mechanical improvements, engine reprogramming	16%
Operator training	9%
Improved per unit data and control	9%
Improved aerodynamics	7%
Auto-inflation	5%
Synthetic oil	5%
More efficient engines	5%
Wide-double tires	2%
reduce fuel leaks	2%

Table 56 - Changes interviewees plan to make to improve the performance and emissions of their vehicles

Frequency	%
Fleet renewal: vehicle specs chosen to optimize fuel economy for specific routes	40%
Mechanical improvements, engine reprogramming	20%
Improved per unit data and control	13%
Improved aerodynamics	13%
Operator training	7%
Alternative fuels	7%

There was quite a lot of interest amongst all the fleets interviewed that know of the program on improving their trip scheduling. The main focus of the larger fleets is on Enterprise Resource Planning / Fleet planning / Logistics planning; Route analysis/optimization; and Analysis of peak hour traffic and movements (taken together represent 60 percent of actions taken) – see Table 57.

Very little additional effort was planned by the interviewees in this field. Those that are taking actions to improve trip scheduling will continue, but others that have not done much to date do not plan to increase their level of effort.

Table 57 - Changes made to improve travel scheduling

Frequency	%
Enterprise Resource Planning / Fleet planning / Logistics planning	27%
Route analysis/optimization	20%
Analysis of peak hour traffic and movements	13%
Operators: Training/ on-road assistance / rest program prior to trips	13%
Freight consolidation	7%
Logistic planning using new highways	7%
Implement productivity monitoring center	7%
Telemetry for transport management (OTM, GEOTAB)	7%

The interviewees were asked for their opinions on what other things could be done to modernize and improve the efficiency of transportation in Mexico (seeTable 58).

Top of mind was improving fuel quality (low sulfur) to allow cleaner engine technology; then improve fleet renewal through better incentive programs, lower interest rates and higher tax breaks. Third on their list is improving the highways and infrastructure with better road surfaces (highway and urban) and new/improved roads for the principal logistics' corridors. This had the same response as reducing corruption and bureaucracy.

Table 58 - What other things do you think could be done to modernize and improve the efficiency of transportation in Mexico?

Frequency	%
Cleaner diesel	21%
Fleet renewal, incentives, tax breaks, interest rates	18%
Highways and infrastructure	15%
Bureaucracy, corruption	15%
Security, highway and truck stops	8%
Military check points; reduce/improve	8%
Operator training	8%
Logistics and communication	5%
Foreign investment	3%

Present fuel standards dictate that sulfur content of diesel should not exceed 15 ppm in the larger metropolitan areas, USA border region and main transport corridors, but elsewhere diesel is still sold at 500 ppm maximum. This fuel is unsuitable for vehicles conforming to Euro 3 standards and onwards Adopting exclusively ultra-low sulfur fuel for on-road diesel vehicles is essential to allow modern, clean diesel engine technology—as used in the USA and in Europe—to be adopted in Mexico. This would

provide a reduction in fine particulate matter emissions by up to 99.9 percent. Fine particulate matter ($PM_{2.5}$) penetrates deeply into the lungs and has a severe impact on health, and health cost.

Several of the interviewees mentioned the need to improve security on the highway and at truck-stops; they also complained about the time delays due to the military check points, suggesting that some check points could be removed, that the personnel manning them need better training and that procedures should streamline the processing of vehicles.

Challenges and barriers

Although Transporte Limpio has made progress, there are several key challenges and barriers which prevent the program from being more effective.

Budget and Outreach

According to fleets that participate in the program, Transporte Limpio currently operates with a virtually non-existent budget and only two part-time dedicated staff. This severely hampers Transporte Limpio's ability to reach the medium and small transport fleets who would benefit the most from the program, as expressed by Francisco J. Barrera Martínez from the Ministry of Environment of the State of Mexico. Smaller carriers lack financial capability and the methodology necessary to analyze the economic benefits of participating in the program.

Transporte Limpio is, at times, perceived as an elitist program rather than an energy and emission-saving program. The limited participation of Owner-operators and small/medium fleets has been generally due to a lack of understanding of its benefits, together with a general perception that their units are in a "good enough condition"[40].This is further compounded by owner-operators and small fleets frequently not fully understanding their operating costs and the savings associated with the use of newer vehicles.

Consolidation and scope

One of the key issues related to Transporte Limpio is the lack of scope of the program and lack of consolidation with the Fleet Modernization Program and Fleet Scrappage Scheme. Though these three programs as a collective bring the Mexican freight picture close to that of SmartWay, its effectiveness is limited by this lack of connection, something which the Mexican Freight NAMA is trying to overcome.

[40] http://transferproject.org/wp-content/uploads/2014/04/Reporte-Final-GIZ-Radiografia-mayo-2014.pdf

This lack of scope and consolidation is reflected in the amount of measures provided by SmartWay against Transporte Limpio, as shown in Table 61.

Marketing

Whilst Transporte Limpio does market itself, it has been recognized that there is an overall lack of information on the program, and lack of awareness, particularly among small carriers[41]. Often smaller carriers are unaware of the current costs associated with their ageing units, and the benefits of moving to more efficient newer vehicles, and this has restricted the program's progress.

SmartWay on the other hand has promoted itself as a brand, both in the USA domestic market and internationally, through SmartWay approved technologies and vehicles, and giving freight carriers and user groups' certification. This in turn sends clear messages to suppliers, consumers, and the wider public about a company's commitment to environmental sustainability[42].

Table 59 - EXAMPLES OF SMARTWAY BRANDING. EPA (2016)

[41] http://transferproject.org/wp-content/uploads/2014/04/Reporte-Final-GIZ-Radiografia-mayo-2014.pdf
[42] https://www.epa.gov/sites/production/files/2016-05/documents/smartway_2020_vision_report.pdf

Financing

Transporte Limpio (and the Federal Fleet Modernisation and Scrappage schemes) also compares poorly to SmartWay in terms of financing. Overall, the scheme receives low national funding[43], which could explain its overall lack of measures and scope, and ability to market itself. Additionally, there are a lack of financial inroads for carriers, and those which are present are not readily accessible to smaller carriers due to restrictions such as proof of economic solvency. Further as identified by[44].interest rates on unpaid balances in Mexico fluctuate around 20 percent, where as in the USA they are on average around 3 percent, which again presents a barrier.

Regulatory Issues

The last and possibly the most critical challenge for Transporte Limpio is regulatory. Some sources have acknowledged that programs such as Transporte Limpio were not a priority on the Mexican government's environmental agenda, potentially contributing to a lack of funding and marketing[45]. Further, lax emissions control and testing [46]has allowed carriers to continue using vehicles which are more polluting and less fuel efficient, and thus reinforces a perception that their vehicles are suitable[47].

Technology evaluation

Speaking on the experiences with new equipment to reduce energy consumption, SEMARNAT disclosed "We do not really evaluate the technologies. The technologies that we promote are those that come from the United States, but we do not really evaluate what potential or benefits they can have here in Mexico". . Since currently there are not standards from test being done by programs such as Transporte Limpio, fleets have been running test to figure out what combination of technologies can give the most cost-saving when operating in Mexican highways and conditions. Energy-reducing technologies already exist in the Mexican freight sector, however, the use of the technology is not standardized, and the results from fleet testing the technologies is not widely spread within the sector. According to one of the interviewees "Of all the tests we have had, only automatic tire inflation systems is the one that has given us the return of investment in a short time", which is a useful and specific piece of information that would not be available to other transport enterprises through government programs such as Transporte Limpio since they only information the program receives from fleets is on general fuel consumption, further highlighting the need for more monitoring, more technology testing, and increase data sharing.

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[43] CTS EMBARQ. (2009b). Final report MEDEC. Transport Sector. World Bank.
[44] http://ccap.org/assets/Schmid-Freight-Transport-NAMAs-in-COL-and-MEX.pdf
[45] http://mexico.itdp.org/wp-content/uploads/Oportunidades-Crecimiento-Verde-Mexico-ed.-transporte1.pdf
[46] CTS EMBARQ. (2009b). Final report MEDEC. Transport Sector. World Bank.
[47] http://transferproject.org/wp-content/uploads/2014/04/Reporte-Final-GIZ-Radiografia-mayo-2014.pdf

Technology adoption

The use of new technologies represents a major challenge for the freight sector in Mexico. Extra equipment on trucks represent not only extra investment on each truck, but also extra risk. Transport companies find themselves taking into consideration multiple factors when considering investing on extra equipment. One such factor is what they refer to as "steal-ability": the risk and potential cost of having the equipment or the truck stolen.

Areas for future development

Most fleets interviewed agreed that the first step towards making the program more robust and with better coverage is increasing the quality and quantity of monitoring and data collection. Currently, Transporte Limpio evaluates participating fleets based on the data that each wishes to share. It gives recognition to those who comply with certain specifications. The present goal is to reward companies for good sustainable environmental practice, arguing that socially responsible companies will be more appealing to customers. However, the program is in need of strengthening. Interviewees agree that the compensations should be greater and, as Alex Theissen Long of FEMSA put it, "it is no longer enough for companies to just sign up". There should be increased efforts from, both, the program (SEMARNAT) and the participants to improve freight conditions. As pointed out by Rafael Tapia Velázquez of BIMBO, the potential benefits of a robust Transporte Limpio program are palpable. A robust program would reduce the amount of fuel required per unit of goods transported and thereby reduce the need to import fuel, and improve air quality.

There are a number of areas that offer considerable potential:

1. **Leverage of the future emissions standard NOM-044**
    - Could be used as an incentive for carriers to renew their vehicles.
    - Could be leveraged to better regulate older freight vehicles.

2. **Increase marketing of Transporte Limpio**
    - Increase freight sector awareness of the scheme – particularly amongst owner-operators and smaller carriers (under 30 vehicles)
    - Increase awareness of the benefits of the scheme, through materials such as carbon and fuel savings calculators, which can be made available to suppliers.
    - Increase partner recognition – similar to the SmartWay approval system.
    - Increase brand promotion to increase public and market awareness.

3. **Improve data collection and recovery**
    - Further develop the FLEET model for Mexican application.
    - Increase data recovery from technologies – which may encourage investment.

4. **Increase financing options for carriers**
    - Develop a series of financing options which are more accessible for smaller carriers.

5. **Improve links between Transporte Limpio and Fleet Modernisation and Scrappage programs**
    - Consideration of consolidation of the three programs into one (currently being proposed as part of the Freight Sector NAMA).
    - Encourage users of Fleet Modernisation and Scrappage programs to sign up and use Transporte Limpio and vice versa.

Further homologation with SmartWay

SmartWay is more extensive then Transporte Limpio. It is estimated that SmartWay has mitigated 61.7 million tons of CO_2 and has saved 144.3 million barrels of oil being used as fuel. Additionally, SmartWay now has over 3,000 partners across the USA and Canada, and approximately 750,000 vehicles are now in the program, accounting for approximately 17 percent of the total road freight fleet

Table 60 shows the current performance of Transporte Limpio against SmartWay, in terms of number of partners, vehicles in program, and fuel and CO_2 savings.

Table 60 - SmartWay and Transporte Limpio performance statistics

Indicator	Transporte Limpio	SmartWay
Partners	Approx. 334 (2017)	Over 3,000
Number of trucks in program	19,000 (2014)	Approx. 750,000 (2014)
Total freight fleet	443,058 (2016)	4.396 million (2013)
Fuel savings	>11.2m barrels cumulatively (2014)*	144.3 million barrels (2014)
Fuel cost savings	-	$20.6 billion cumulatively (2014)
CO^2 savings	>4.8 million tonnes (2014) cumulatively	61.7 million tonnes (2014)
NO_X savings	-	1.458 million tonnes
PM savings	-	59,000 tonnes

Source: Consultant derived

Table 61 meanwhile shows the current host of measures which form part of SmartWay against Transporte Limpio. As can be identified, the measures which form Transporte Limpio are limited in comparison to SmartWay, with gaps in measures related to partner materials and marketing, such as carbon and fuel assessment tools, and partner recognition. Additionally, as noted, some of the measures such as the FLEET model and finance programs are restricted in comparison to SmartWay. For example, under Transporte Limpio financing is only available for technologies. Financing for vehicles, as mentioned previously, is covered under the separate Fleet Modernization program.

Table 61 - SmartWay measures against Transporte Limpio

Measure	SmartWay	Transporte Limpio
Assess, benchmark and track emissions of carriers, shippers and logistics companies (FLEET Model)*	✓	✓
Idle reduction program	✓	✓
Speed reduction	✓	✓
Carbon assessment tools	✓	
Partner Support (PAM, helpline)	✓	
GHG and fuel savings calculator	✓	
Technology test program (grants to test technology)	✓	
Approved tractors/trailers	✓	
Approved technologies	✓	✓
Driver training	✓	✓
Finance programs (for vehicles and technology)**	✓	✓
Finance website	✓	
Partner recognition	✓	
Partner education	✓	✓
Brand marketing***	✓	✓
International activity	✓	
Light duty vehicles & cars	✓	

* FLEET Model adapted for Mexico from EPA (SmartWay)

** Financing of new fleet covered by Programme for Modernisation of the Federal Motor Carrier Fleet in Mexico

*** Transporte Limpio not as intensive as SmartWay

Most interviewees see the benefits of increased harmonization of Transporte Limpio with the SmartWay program. Although there would be many barriers to implementation that would need to be overcome, the potential benefits of harmonizing could be substantial.

The principal challenge is how to get small, and medium-size fleets involved. The program has successfully reached out to large fleets, who are the least to benefit from harmonization as they already comply with many of the SmartWay specifics. Some of the large companies interviewed are operating fleets that currently meet SmartWay standards due to their international business dealings in the NAFTA region. Because of this, vehicle and trailer manufacturers are offering products that meet SmartWay standards. Both Alejandro Fuentes Romero of GREAT DANE and Adrián Azuara Perdomo of FREIGHTLINER mentioned that their companies' choice of tires is in full consideration of SmartWay protocols.

Smaller fleets, however, have not, in general, appreciated the benefits of Transporte Limpio or of moving towards harmonization. Many see these programs as little more than an extra cost item for them. As freely admitted by SEMARNAT, there is general mistrust toward the government and government run programs, which extends particularly to any form of data collection or "standardization".

Harmonization could provide the methods to measure the data and the standardization that the freight sector in Mexico so direly requires. In order to address the issue of mistrust towards governmental entities, Francisco J. Barrera Martínez of the Ministry of Environment for the State of Mexico proposed the establishment of an independent research organization with little or no governmental ties. This organization or group would be tasked with the management, upkeep and overseeing of the transport sector in accordance to standardized practices and methodologies. The group would serve as the focal point of data gathering for the implementation of the Transporte Limpio programs as well as general transport sector research. Currently there are no plans for creating such group or clarity on how to fund it.

How far can Transporte Limpio go in the next 10 years

SEMARANT expressed their objective of increasing the amount of companies involved in the program by 15 percent but this is limited by the sparse funding and personnel dedicated to the program. The large transport companies interviewed do not believe the goal to be ambitious enough. Other programs within the NAFTA region, such as SmartWay, have up-to-date tools and set standards and methodologies which they can apply across the U.S. A percentage increase in program participation will not be sufficient in its mitigation actions. Based on global freight trends, and according to the interviewees, in the next decade the Transporte Limpio program should, at the very least, aim to establish fuel economy standards, a model year cap, and criterion for companies to start to enact a fleet renewal system. An overall goal for the incoming years must be to calculate and disperse knowledge on the real costs of participating or not in the program, simplifying and improving data collection.

Leverage the tri-lateral SmartWay automotive sector pilot.

A pilot project is planned for the near-term and will be administered by the Automotive Industry Action Group. The primary objective is to focus on automotive companies with operations across Canada, the USA, and Mexico and develop a framework for more harmonized used of SmartWay tools and processes.

We could find no evidence of highway tractors being considered or involved in this program.

Program for the Modernization of the Federal Motor Carrier Fleet

The Program for the Modernization of the Federal Motor Carrier Fleet has been developed and promoted by the SCT and the Mexican development bank NAFIN (Nacional Financiera). The program

provides funding and tax incentives for the acquisition of new or nearly new (up to 6 years old) trucks to improve the fleet efficiency and reduce its emissions. To increase the distribution of credit and thus encourage the renewal of more units, Federal Government provides support to financial intermediaries. As of 2012, approximately 48,019 lower emission vehicles have been financed under the scheme[48]

Challenges and barriers

The biggest challenge associated with the Fleet Modernization Program is the inability for small carriers and owner-operators to meet credit requirements.This is mainly due to seasonal cash flows, the difficulty to keep operation's records and to show evidence on economic solvency[49].

Tax credits, whilst useful to the larger fleets and private companies are not much of an incentive to those owner-operators who participate in the informal sector of the economy, or are barely making a profit.

All interviewees agreed that the incentives have to be increased, possibly linked to carbon bonds. FEMSA proposed that it would be better to split the payment: half to the one who is selling the pre-owned truck, and the other half to the Owner-operator. This could incentivize the fleet who sold the pre-owned truck, and bought a new one, and also the Owner-operator who bought the pre-owned truck and delivered the scrap.

Many also commented on the need for a law to limit the age of heavy duty trucks with federal plates, similar to what has been implemented for a long time on coaches[50]. The application of the law could be gradual: For example, that says, "Within a year all trucks over 20 years in Mexico will no longer be able to circulate. In two years' time, the maximum age could be reduced to 19 years, and so on". This would help fuel economy, emissions, safety and slowly move the owner-operators and smaller feeder lines into the formal sector.

Most interviewees commented that government programs that give credit to renovate units or buy more units and expand the fleet usually come with disadvantageous conditions and high interest rates. They commented that PACCAR or KENWOTH for example give a much better deal, with more facilities and a process that is not so cumbersome. Fleets rarely choose to participate in government plans if they have other options because of the associated barriers and costs.

[48] http://mexico.itdp.org/wp-content/uploads/Altas-emisiones-Baja-eficiencia.pdf
[49] http://transferproject.org/wp-content/uploads/2015/12/GIZ-TRANSfer-Documento-NAMA-Autotransporte-Federal-Carga.pdf
[50] Coaches have a maximum age limit of 10 or 15 years according to the type of service they provide See: http://dof.gob.mx/nota_detalle.php?codigo=5387322&fecha=31/03/2015

Federal Motor Carrier Scrappage Scheme

The Mexican Scrappage Scheme is operated by Mexican government, through the SCT, it promotes the replacement of trucks over 10 years old. In exchange of the scrappage of the old truck, the program provides an incentive of up 15 percent of the value of a new unit (approximately $225,000 MXN) [51]Between 2004 and 2014, more than 22,000 trucks have been scrapped, and approximately 1.5 million tons of CO_2 has been mitigated. In May 2015, the scheme was updated, bringing the maximum financial incentive to approximately $250,000 MXN[52].

Challenges and barriers

The challenges faced under the scrappage scheme are linked closely to that of the fleet renewal scheme, largely due to a lack of funding within the program. This has led to incentives often being below the market value of the old unit (Table 62), leading to operators selling their old units rather than scrapping. The fleets interviewed commented that when they do the analysis, they see that it is better to continue working the old unit, which gives a more favorable cost-benefit than participating in the scrappage program. It is even better for them to sell the unit on the open market before going to a Scrap Program, because the incentive is too low.

Additionally, the lack of coordination between the Fleet Modernization Program has led to more vehicles entering the fleet than being scrapped[53].

Table 62 - : Current scrappage incentives against value of old vehicles

Vehicle	Value 20 year truck (Euros)	Vehicle age	Value new truck	Scrappage allowance (%)	Scrappage allowance (Euro)	Cost of change (Euro)
C3 (20t)	8,000.00	New	61,142.86	15%	6,827.43	54,315.43
	8,000.00	5-8 secondhand	14,600.00	15%	2,190.00	12,410.00
T3	13,500.00	New	84,000.00	15%	10,672.00	73,328.00
	13,500.00	5-8 secondhand	25,500.00	15%	3,814.29	21,614.29

Source: http://transferproject.org/wp-content/uploads/2014/07/D2_6_Truck-Scrapping-Improvement_Schmid.pdf

[51] http://ccap.org/assets/Schmid-Freight-Transport-NAMAs-in-COL-and-MEX.pdf
[52] http://www.keepeek.com/Digital-Asset-Management/oecd/governance/review-of-the-regulation-of-freight-transport-in-mexico_9789264268364-en#.WZbLiSiGNPY
[53] http://ccap.org/assets/Schmid-Freight-Transport-NAMAs-in-COL-and-MEX.pdf

Future policies and programs

Mexican Official Standard NOM-044

The Mexican Standard NOM-044-SEMARNAT-2006 which defines maximum emissions from heavy duty engines and vehicles is under revision. The new version of NOM-044 was expected to enter as from Jan, 1, 2019 but has been delayed principally due to the necessity of nationwide availability of ultra-low sulfur diesel fuel, needed for EPA 2010/Euro 6 vehicles. The draft version of the standard has just been circulated for public comments (Aug, 2017) and it is expected that there could be a delay of one year for it to enter force. Miguel Elizalde, president of the manufacturer's association (ANPACT) has been very insistent that "The automotive heavy-duty industry needs legal certainty to adjust production lines well in advance, but we do not have it 18 months [before the expected implementation date], so it is urgent that SEMARNAT publish the standard at the earliest opportunity".

The update to NOM-044, basically states that from 1 January 2019, limits equivalent to EURO VI / EPA 2010 must be met. However, EURO IV / EPA 2004 vehicles will still be allowed to be marketed for six months after that date and vehicles that comply with limits equivalent to EURO V may be marketed for two years (until 1 January 2021)[54].

Whilst NOM-044 does not directly target GHG emissions, it is expected to do so due to improved efficiency of new trucks. In parallel, Mexico also intends to develop an energy efficiency standard for heavy duty vehicles to improve fuel efficiency[49]. This standard is likely to be based on the USA proposals which are currently in flux. The EPA's intention to define fuel economy standards for the tractor-trailer combination has received heavy negative lobbying from the industry mainly because the tractor and trailer units are produced by different manufacturers which makes combined certification more complicated. In addition, the current political framework is likely to lead to a delay in implementation.

Federal Road Freight Transport NAMA (for owner operators and smaller fleet carriers)

The Federal Road Freight Transport NAMA (Nationally appropriate mitigation action) is a program currently being developed under the Mexican-German NAMA Program. The main aim of the NAMA is to improve the energy efficiency of the road transport sector through measures similar to the current

[54] The 2006 publication of the NOM allowed SEMARNAT, in January 2017, to evaluate the national availability of ultralow-sulfur diesel in order to determine if the conditions exist for compliance with the B standards. This evaluation was deemed insufficient and the standard was delayed by 12 months. Similarly, a provision was enacted to allow manufacturers to sell existing inventories of vehicles that were produced during the application of standard A for up to six months after the implementation of standard B. The intent was to provide a reasonable period of transition while protecting against stockpiling of old inventory.

federal suite of programs, focusing largely on owner operators (up to 5 vehicles) and small fleet carriers (up to 30 vehicles). These include:

1. Eco driving courses and training - for drivers as part of bi-annual SCT courses – expected CO_2 saving of 2-3.5 million tons/year[55].This program involves:
   - Creation of a national network of trainers/training centers
   - Creation of an online training platform
   - Development of program evaluation and monitoring for training
   - Development of training materials and technical guidance
   - Green license – certification of 'professionalism' for drivers, good unit status and consumption of cleaner fuels[49].
2. Technological improvements – such as aerodynamic improvements and auto tire inflation systems – expected CO_2 saving of 0.3-1 million tons/year [55]
3. Modernisation of vehicle fleet – via scrappage and renovation of road transport fleet – expected CO_2 saving of 2 million tons/year (average) [55]

The program is expected to cost US$19.76 million to implement[56], and will complement the future Mexican emission standard NOM-044. Under the NAMA, financing would also be available for fuel savings technologies and new vehicles, with some credit guarantees for small enterprises

[55] https://unfccc.int/files/cooperation_support/nama/application/pdf/mexico_nama_final.pdf
[56] http://www.nama-database.org/index.php/Freight_transport_NAMA

Chapter 9:- Fuel efficiency and emissions standards

This chapter compiles information on fuel efficiency and critiera pollutant emissions standards in Mexico and in the USA.

Chapter Highlights

In Mexico

New Vehicles

The current applicable emissions standard for new highway tractors with diesel engines is: NOM-044-SEMARNAT-2006 which requires compliance with EURO IV / EPA 2004.
The US Heavy duty diesel vehicle emissions standard compliance for EPA 2010 is available in this market but not yet generally adopted and not enforced.

The update to the heavy-duty diesel emissions standard, which will soon be published, basically states that from 1 January 2019, limits equivalent to EURO VI / EPA 2010 must be met. However, EURO IV / EPA 2004 vehicles will still be allowed to be marketed for six months after that date and vehicles that comply with limits equivalent to EURO V may be marketed for two years (until 1 January 2021).

The proposed standards require the installation and operation of full On-Board Diagnostic (OBD) systems on all new vehicles.

In-use vehicles

The current emissions standard for the verification of in-use diesel vehicles is the NOM-045-SEMARNAT-2006 for national coverage and NOM-EM-167-SEMARNAT-2016 specifically for vehicles circulating in Mexico City, Hidalgo, State of Mexico, Morelos, Puebla and Tlaxcala. These standards limit exhausrt opacitiy, when subjected to a free-acceleration test procedure

Fuel efficiency stanard

There is currently no fuel efficiency standard applicable to highway tractorsin Mexico

In the USA

The US implemented strict emissions standards for Heavy duty diesel vehicles in 2010 (EURO VI / EPA2010) and has focused on improving fuel economy in this segment over more recent years.

In the U.S., average tractor-trailer fuel consumption rates for the entire fleet are approximately 2.6 km/L (6 mpg) compared to 2.9 km/L found in these surveys in Mexico. Significant differences in average vehicle speed, vehicle loading and altitude can account for this.

For the newest U.S. models, fuel consumption is typically between 2.8 and 3.0 km/L (6.5–7 mpg). A fleet-wide analysis done for the European Commission estimates tractor-trailer fuel consumption at roughly 3.2 km/L, however, there is not sufficient information to say definitely if the U.S. or EU has more efficient trucks.

The U.S. set standards beginning in 2014 model year with more stringent standards following in 2017 model year. These represent an overall fuel consumption and CO_2 emissions reduction up to 23 percent from the tractors and the engines installed in them when compared to a baseline 2010 model year tractor and engine without idle shutdown technology. Phase 2 standards would be introduced over a long term, starting in 2021 and culminate in 2027. The standards differ by cab type and roof height and are planned to achieve a further 24 percent reduction in CO_2 emissions and fuel consumption. However, the present government has made public its intention to review and revise these limits.

Emission standards for new heavy duty diesel vehicles in Mexico

The current applicable emissions standard for new highway tractors with diesel engines is: NOM-044-SEMARNAT-2006

Emissions standards for both light- and heavy-duty vehicles were first established in 1988 and became effective in model year 1993 (NOM-044-ECOL-1993). The standard NOM-044-SEMARNAT-2006 was adopted in 2006 as an update to NOM-044-SEMARNAT-1993, and it establishes emission limits for total hydrocarbons, non-methane hydrocarbons, carbon monoxide, nitrogen oxides, particles, and opacity for new heavy-duty diesel engines. NOM-044 is currently under revision. The new version of NOM-044 is expected to enter as from Jan, 1, 2019 but may suffer a one-year delay.

Diesel Engine Standards

1993-2014

Emission standards for new heavy-duty diesel engines first became effective in model year 1993 and were based on US 1991 and later requirements, including the US Environmental Protection Agency (EPA) FTP transient test cycle. Standards for MY 1993-1998 were equivalent to USA standards and compliance could be demonstrated through certification by US EPA. Under NOM-044, engines in Mexico are provided compliance options and can meet European standards, as measured on the official European test cycles (ETC[57] and ESC[58]), as an alternative to the EPA-based standards; compliance with standards can be demonstrated through:

- Letter or proof issued by motor manufacturer, including invoice of the testing laboratory,
- Certificate or proof issued by the Environmental Protection Authority of the country of origin or country of certification, or
- Certificate issued by Certification Bodies for the country of origin or country of certification.

In 2006, the standard NOM-044-SEMARNAT-2006 was adopted as an update to NOM-044-ECOL-1993. It establishes emission limits for total hydrocarbons, non-methane hydrocarbons, carbon monoxide, nitrogen oxides, particles, and opacity for new heavy-duty diesel engines. The standard allows compliance with either US 2004 or Euro IV equivalent standards. The emission standards compliance timeline and current equivalent limit values of the 1993 and 2006 standards are outlined below.

Mandatory compliance with EPA 2004/Euro IV standards began in July 2008, however, the relevant standard was modified in 2011 by SEMARNAT to extend the regulatory timeline for compliance with EPA 2004/Euro IV standards to June 2014.

[57] The ETC test cycle is used for emission certification of heavy-duty diesel engines in Europe starting in the year 2000 (Directive 1999/96/EC of December 13, 1999). The ESC and ETC cycles replace the earlier R-49 test. The ETC cycle was developed based on real road cycle measurements of heavy duty vehicles

[58] The ESC test cycle was introduced, together with the ETC (European Transient Cycle) and the ELR (European Load Response) tests, for emission certification of heavy-duty diesel engines in Europe starting from the year 2000 (Directive 1999/96/EC of December 13, 1999). The ESC is a 13-mode, steady-state procedure that replaces the R-49 test.

Table 63 - Max. Permissible Emissions Standards; Heavy-duty Vehicles Compliance

Max. Permissible Emissions Standards Heavy-duty Vehicles Compliance	
Year	Compliance Equivalent
1993	US EPA 1991
1994	US EPA 1994
1998	US EPA 1998
2006-2008	US EPA 1998 or Euro III
2008†	US EPA 2004 or Euro IV
Notes: **† extended through 2014.06; later requirements are not specified.**	

Source: http://transportpolicy.net/index.php?title=Mexico:_Heavy-duty:_Emissions#Overview

Table 64 - Maximum Permissible Emissions for Heavy-duty Vehicles in g/bhp-hr

	Maximum Permissible Emissions for Heavy-duty Vehicles limit values expressed as grams per brake horsepower-hour (g/bhp-hr)						
Standard	HC	NMHC+NOx	CO	NOx	Smoke opacity % (acceleration)	Smoke opacity % (pull)	Smoke opacity % (peak)
A[1]	1.3	N/A	15.5	4.0	20	15	50
B[2]	N/A	2.4[3]	15.5	N/A	20	15	50

Notes:

1. Standard A Maximum permissible limits for engines and/or new units produced from 2006 until June 2008, obtained using the FTP (Federal Test Procedure) heavy-duty transient cycle.

2. Standard B Maximum permissible limits for engines and/or new units produced from July 2008 until July 2014, obtained using the SET (Supplemental Emissions Test).

3. Limit value could be 2.5 provided the NMHC are less than 0.5

Source: http://transportpolicy.net/index.php?title=Mexico:_Heavy-duty:_Emissions#Overview

Table 65 - Maximum Permissible Emissions for Heavy-duty Vehicles in g/kwhr

Maximum Permissible Emissions for Heavy-duty Vehicles limit values expressed as grams per kilowatt hour (g/kwhr)							
Standard	Test Method	HC	NMHC	CO	NOx	Part	Smoke Opacity[3]
A[1]	ESC	0.66	N/A	2.1	5.0	0.10	N/A
	ETC	N/A	0.78	5.45	5.0	0.16	N/A
B[2]	ESC	0.46	N/A	1.5	3.5	0.02	N/A
	ETC	N/A	0.55	4.0	3.5	0.03	N/A

Notes:

1. Standard A Maximum permissible limits for engines and/or new units produced from 2006 until June 2008, obtained using the ESC (European Stationary Cycle) and ETC (European Transient Cycle).
2. Standard B Maximum permissible limits for engines and/or new units produced from July 2008 until July 2014, obtained using the ESC (European Stationary Cycle) and ETC (European Transient Cycle).
3. The European Load Response (ELR) engine test has no applicable limit values in the above table except under Smoke Opacity, where values are 0.8 and 0.5 for standards A and B, respectively.

Source: http://transportpolicy.net/index.php?title=Mexico:_Heavy-duty:_Emissions#Overview

2015-2018

The update to NOM-044, which will soon be published, basically states that from 1 January 2019, limits equivalent to EURO VI / EPA 2010 must be met. However, EURO IV / EPA 2004 vehicles will still be allowed to be marketed for six months after that date and vehicles that comply with limits equivalent to EURO V may be marketed for two years (until 1 January 2021)[59].

The proposed regulation will still apply to diesel engines or full vehicles with a gross vehicle weight above 3,857 kg. The following table shows the timing and certification requirements of the proposed standard. Standard A, in force from the adoption of the proposal through 2017, is essentially the same as the current NOM-044 standard; starting in 2018, Standard B requires compliance with either Euro VI/6 or EPA 2010 standards.

Table 66 - Framework of the proposed standards for 2019

Framework of the proposed standards		
Timeframe	NOM-044 Standard	Certification Requirement
2015-2018	1A	EPA 2004
	2A	Euro IV
Beginning Jan. 1, 2019	1B	EPA 2010
	3B	
	2B	Euro VI
	4B	Euro 6

Source: http://transportpolicy.net/index.php?title=Mexico:_Heavy-duty:_Emissions#Overview

Limit values

Limit values for heavy-duty engines are shown in the following tables. Limits are set in grams per brake horsepower-hour (g/bhp-hr) for EPA 2004 and EPA 2010 standards, and are in grams per kilowatt-hour (g/kWh) for Euro IV and Euro VI standards. Particle number and ammonia (NH3) limits are set as part of the Euro VI standards but have not been defined as limit values under EPA standards.

[59] The 2006 publication of the NOM allowed SEMARNAT, in January 2017, to evaluate the national availability of ultralow-sulfur diesel in order to determine if the conditions exist for compliance with the B standards. This evaluation was deemed insufficient and the standard was delayed by 12 months. Similarly, a provision was enacted to allow manufacturers to sell existing inventories of vehicles that were produced during the application of standard A for up to six months after the implementation of standard B. The intent was to provide a reasonable period of transition while protecting against stockpiling of old inventory.

Table 67 - U.S. certification limit values for heavy-duty engines

U.S. certification limit values for heavy-duty engines									
Certification Requirement	Standard	Test Method	CO	NO_x	NMHC	HCNM + NO_x	PM	Particle Number (#/kWh)	NH_3
			g/bhp-hr						
EPA 2004	1A	SET & FTP	15.5	–	–	2.4	0.10	–	–
					0.5	2.5		–	–
EPA 2010	1B	SET & FTP	15.5	0.20	0.14	–	0.01	–	–

Source: http://transportpolicy.net/index.php?title=Mexico:_Heavy-duty:_Emissions#Overview

Table 68 - European certification limit values for heavy-duty engines

European certification limit values for heavy-duty engines									
Certification Requirement	Standard	Test Method	CO	NO_x	NMHC	HC	PM	Particle Number (#/kWh)	NH_3
			g/kWh						
Euro IV	2A	ESC	1.5	3.5	–	0.46	0.02	–	–
		ETC	4.0	3.5	0.55	–	0.03	–	–
Euro VI	2B	WHSC	1.5	0.4	–	0.13	0.01	8.0×10^{11}	10
		WHTC	4.0	0.46	–	0.16	0.01	6.0×10^{11}	10

Source: http://transportpolicy.net/index.php?title=Mexico:_Heavy-duty:_Emissions#Overview

Useful life is defined as the reference values (measured in vehicle-km and years) that are used in durability tests for new engine or vehicle certification. Useful life does not refer to in-use vehicle emissions, nor is it equivalent to the manufacturer warranty.

Table 69 - Useful life requirements

Useful life requirements				
Certification Requirement	Standard	Gross Vehicle Weight (kg)	Useful Life	
			Distance (km)	Time (years)
EPA 2004 & EPA 2010	1A & 1B	3,857 - 8,845	177,023	10
		8,846 - 14,970	297,721	
		14,971 and larger	700,046	
Euro IV	2A	3,857 - 15,999	200,000	6
		16,000 and larger	500,000	7
Euro VI	2B	3,857 - 15,999	300,000	6
		16,000 and larger	700,000	7

Source: http://transportpolicy.net/index.php?title=Mexico:_Heavy-duty:_Emissions#Overview

On-Board Diagnostics and Compliance Inducements

The proposed standards require the installation and operation of full On-Board Diagnostic (OBD) systems on all new vehicles. The type of OBD system must be recorded in the certification

documentation. Appendix B of the proposal provides a detailed explanation of the general system requirements and attendant documentation. As both EPA and Euro standards require the full phase-in of OBD systems before 2019, the proposal relies on certification documentation as the primary proof of compliance with OBD requirements. Similarly, the proposal requires that new vehicles and engines that use a reagent for NO_x-reducing SCR systems are also equipped with operating alerts and driver inducements to ensure the correct functioning of these systems. These fail-safes include lights, auditory alarms and requirements to safely limit vehicle operation in the case of improper use, such as poor-quality diesel exhaust fluid (DEF) or insufficient DEF supply.

Emission standards for In-use Heavy Duty diesel vehicles in Mexico.

The current emissions standard for the verification of in-use diesel vehicles is the **NOM-045-SEMARNAT-2006** for national coverage and NOM-EM-167-SEMARNAT-2016 specifically for vehicles circulating in Mexico City, Hidalgo, State of Mexico, Morelos, Puebla and Tlaxcala.

NOM-EM-167-SEMARNAT-2016 covers all in-use vehicle emissions testing in these states. The principal programs are operated by Mexico City (www.sedema.cdmx.gob.mx) and the State of Mexico (sma.edomex.gob.mx), who developed this standard in conjunction with SEMARNAT to provide a more stringent test, add the review of on-board diagnosis of vehicles and their emissions, and establish the characteristics of remote sensing devices.

NOM-045-SEMARNAT-2006 was anteceded by NOM-045-SEMARNAT-1996 (published on April 22, 1997) which replaced NOM-CCAT-008-ECOL/1993[60]. For all these standards, the applicable test for heavy duty diesel vehicles is a static verification of exhaust opacity levels with the engine under free acceleration.

[60] That was renamed to NOM-045-ECOL-1993 on November 29, 1994

Previous limits

NOM-045-SEMARNAT-1996 Limits for vehicles of over 2,727 kgs PBV

Table 70 - NOM-045-SEMARNAT-1996 Limits for vehicles of over 2,727 kgs PBV

Model year of engine	Coefficient of light adsorption (m-1)	Percent opacity (%)*
1990 and earlier	1.99	57.61
1991 and later	1.27	42.25

Source: NOM-045-SEMARNAT-1996

Current Limits

NOM-045-SEMARNAT-2006 Limits for diesel vehicles of over 2,727 kgs PBV

Table 71 - NOM-045-SEMARNAT-2006 Limits for diesel vehicles of over 2,727 kgs PBV

Model year of engine	Coefficient of light adsorption (m-1)	Percent opacity (%)*
1990 and earlier	3.0	72.47
1991 and later	2.5	65.87

Source: NOM-045-SEMARNAT-2006

NOM-EM-167-SEMARNAT-2016 Limits for diesel vehicles of over 2,727 kgs PBV

Table 72 - NOM-EM-167-SEMARNAT-2016 Limits for diesel vehicles of over 2,727 kgs PBV

Model year of engine	Coefficient of light adsorption (m-1)	Percent opacity (%)*
1990 and earlier	2.25	61.99
1991 and later	1.50	47.53

Source: NOM-EM-167-SEMARNAT-2016

Test procedure

The test procedure in all these versions of the NOM consists in a procedure whereby with the vehicle stationary, the engine, is rapidly accelerated three times from its idle speed to its governed speed. The maximum opacity measures during this acceleration is averaged over the three tests and compared to the applicable limit.

This Official Mexican Standard partially agrees with the American Standard SAE-J-1667.-Snap-acceleration smoke test procedure for heavy-duty diesel-powered vehicles Issued 1996-02. It uses the Instantaneous Acceleration Opacity Test Procedure for Diesel Engine Heavy Vehicles, February 1996. U.S.A.

Test Frequency

Vehicles are required to be tested in an official test center every semester

Test Facilities

Almost all highway tractors use federal (SCT) license plates. These have to be tested every six months in a test center authorized by SCT of which there are 250 authorized in the country[61].

For vehicles to circulate in Mexico City, Hidalgo, State of Mexico, Morelos, Puebla and Tlaxcala, the test must be carried out in an SCT-authorized test center that complies with NOM-EM-167-SEMARNAT-2016. 155 of the 272 SCT-licensed test centers meet this requirement. Mexico City has 7 centers authorized to test highway tractors

Test Effectiveness

The free acceleration opacity test has been in use for many years. It is a low cost and easy test to perform but suffers from certain limitations:

- The test cycle (snap acceleration from idle to rated rpm) is not one that represents normal driving conditions. Thus, its results have little or no correlation with critical drive conditions when the vehicle is likely to emit smoke (such as lugging up a hill, fully loaded.
- The principal health damage of diesel vehicles is caused by fine particle emissions ($PM_{2.5}$). There is little or no correlation between these and opacity.

[61] plus an additional 22 that serve the needs of specific private companies/organizations

- The opacity level measured in the test is dependent on how fast the tester accelerates the engine. Thus, testers can reduce the reading by accelerating slower, and this test cycle is not conducive to repeatable impartial results.
- Many modern electronically-governed engines do not allow this cycle to be run. The engine management computer can restrict this free acceleration test cycle.

Gasoline-engine light duty vehicles originally used a static emissions test (BAR'90), but this was changed to a dynamometer-based dynamic test, to address similar issues of test repeatability, transparency and to restrict the influence that the test operator can exert on the test results. There is ongoing discussion of moving diesel testing also to a dynamometer but this is a long way from getting written into a new version of the standard.

Test Results

SCT does not publish test results or statistics. Mexico City and the State of Mexico do publish results to researchers for analysis but little is available for highway tractors, and current opacity testing results do not give any useful indication of the vehicles on-road emissions.

Fuel efficiency standards in the USA

In the U.S., average tractor-trailer fuel consumption rates for the entire fleet are approximately 2.6 km/L (6 mpg) compared to 2.9 km/L found in these surveys in Mexico. Significant differences in average vehicle speed, vehicle loading and altitude can account for this.

For the newest U.S. models, fuel consumption is typically between 2.8 and 3.0 km/L (6.5–7 mpg). A fleet-wide analysis done for the European Commission estimates tractor-trailer fuel consumption at roughly 3.2 km/L, however, there is not sufficient information to say definitely if the U.S. or EU has more efficient trucks.

The North American Council for Freight Efficiency (NACFE) summarized truck fleet fuel consumption based on its data set including 40,783 tractors and 125,711 trailers from seven, generally for-hire carriers, two private fleets and one primarily leasing fleet. This study showed average fuel consumption across all ten fleets was 2.8 km/L in 2012 and 2.7 km/L in 2010[62].

The U.S. Environmental Protection Agency (EPA) and the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) set standards beginning in 2014 model year with more stringent standards following in 2017 model year. Table 73 presents the agencies' respective standards for combination tractor manufacturers for the 2017 model year. The standards represent an overall fuel

[62] Source: ICCT 2015, Literature review: real-world fuel consumption of heavy-duty vehicles in the United States, China, and the European Union, Ben Sharpe and Rachel Muncrief

consumption and CO_2 emissions reduction up to 23 percent from the tractors and the engines installed in them when compared to a baseline 2010 model year tractor and engine without idle shutdown technology[63].

Table 73 – Heavy HEAVY-DUTY (Class 8) COMBINATION TRACTOR EPA EMISSIONS STANDARDS (G CO_2/TON-MILE) AND NHTSA FUEL CONSUMPTION STANDARDS (GAL/1,000 TON-MILE)

	Day cab	Sleeper cab
2017 Model Year CO2 Grams per Ton-Mile		
Low Roof	80	66
Mid Roof	86	73
High Roof	89	72
2017 Model Year Gallons of Fuel per 1,000 Ton-Mile		
Low Roof	7.8	6.5
Mid Roof	8.4	7.2
High Roof	8.7	7.1

Building on the success of these standards the EPA and NHTSA have proposed a Phase 2 program that will reduce CO_2 emissions and fuel consumption further. The Phase 2 standards would be introduced over a long term, starting in 2021 and culminate in 2027. The standards differ by cab type and roof height and are planned to achieve a further 24 percent reduction in CO_2 emissions and fuel consumption[64]. However, the present government has made public its intention to review and revise these limits. Fuel economy standards for the tractor-trailer combination have received heavy negative lobbying from the industry mainly because the tractor and trailer units are produced by different manufacturers which makes combined certification more complicated. In addition, there is likely to be a delay in implementation.

[63] Source: Federal Register / Vol. 76, No. 179 / Thursday, September 15, 2011

[64] Source: EPA-420-F-15-901 June 2015: EPA and NHTSA Propose Standards to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy-Duty Vehicles for Model Year 2018 and Beyond

ANNEX:

Approach and Methodology

This project involved the collection, use and analysis of data from three types of source:

a) Information from publicly available sources
b) Market data and analyses from previous work
c) New interview data

a) Information available from public sources

Good information is available from public sources that will be used in this analysis. Examples include:

Vehicle sales

The "Asociación Mexicana de Distribuidores de Automotores" (AMDA), the "Asociación Mexicana de La Industria Automotriz" (AMIA), the "Asociación Nacional de Productores de Autobuses, Camiones y

Tractocamiones." (ANPACT) together with the "Secretaría de Comunicaciones y Transportes" (SCT) and the "Instituto Mexicano del Transporte provide data on new class 8 vehicles sales (including trailers), the breakdown in terms of domestic production versus imports and a guide to vehicle characteristics and technology baseline.

Overall Freight System

The North American Transportation Statistics Database managed in Mexico by the "Secretaría de Comunicaciones y Transportes" is the main source of data for the United States, Canada, and Mexico. Data tables are divided up into 12 categories, including a country overview, transportation flows, safety, environment, trade, and infrastructure. This will be our main source of data for domestic freight activity and merchandise flows, allowing the relative importance of on-road freight to be evaluated, both in terms of its relationship to total national freight flows and allowing a Mexico/US/Canada comparison. The disaggregation by type of vehicle is not maintained up to date in the database (most recent data is 2009), and has to be complemented with data from surveys (see below)

In-use Vehicles

In the same vein, the "Dirección General de Autotransporte Federal" (DGAF) provides statistics on heavy duty vehicle registration (except for the relatively few Class 8 highway tractors on state-plates) but needs data from surveys to be able to differentiate those that are really in commercial use on a continuous basis.

There are no reliable Governmental or Institutional figures showing the vehicle population in Mexico by vocation and fleet size and we have always measured significant discrepancies between vehicle population numbers derived from registration data and the active fleet that is in reality found operating in the country. Whilst the total number of vehicles that we find is surprisingly congruent with official numbers there are significant differences in sub-classification amongst fleet use of older vehicles, which tend to be relegated to owner-drivers. Typically trucks get a major rebuild after 20-25 years (maybe with second-hand trucks and parts that come into Mexico from the USA) and it would seem that they are usually seen by their owners as newer trucks even though they continue to use old registration papers. In Mexico there is no age restriction for freight vehicles. Between 1951 and 1990 the total number of Class 8 vehicles sold in Mexico was 139,756; so for the registration numbers to be valid in-use vehicles, it would mean that every truck sold since 1951 would have to be still in service, which would be highly unlikely and not substantiated by our regular, extensive fleet interviews (see below).

Mobile Source Emissions

The INECC study "Elaboración del Inventario Nacional de Emisiones de Fuentes Móviles para México 2013 y proyección 2030 mediante el uso del modelo MOVES" and other recent mobile source emissions inventory studies will be used as a basis for estimating the GHG and criteria emissions from Class 8 tractor trailers. The analysis will use the EFFECT emissions module (COPERT IV) calibrated to national inventories following the "Guia Methodologica para la estimación de emisiones vehiculares "developed by the INECC, SEMARNAT, and Western Governors' Association. This Excel-based vehicle fuel consumption and emissions model was developed by John Rogers for the World Bank, has been used in peer-reviewed studies in over 18 countries and is freely available from the World Bank, who also offers free, self-paced on-line training.

b) Information available from previous studies conducted by TSTES

TSTES has performed a lot of detailed studies in this field over recent years which provide a solid basis for the present analysis.

MacKay DataMac series of studies

TSTES conducts a detailed study of the heavy duty fleet utilization (including Class 8 highway tractors and trailers) and repair practices in Mexico every four years since 1992 for Mackay & Company, Lombard, Illinois who provide it to heavy duty vehicle manufacturers and component suppliers. The study is highly detailed and extensive involving complex questionnaires of around 11 pages containing questions relating to around 300 different component categories containing 1130 discrete variables. It requires person-to-person interviews of different managers within each fleets organization to validate

from their records vehicle usage and maintenance practices. This information is analyzed by fleet vocation, size of fleet, type and age of vehicle.

The most recent study was 2015. MacKay is permitting us to share the vehicle fleet data from this study with you provided that it is referenced to Mackay & Co.

TSTES/INECC in-use fleet studies

In 2011, TSTES performed a nation-wide study for the INECC entitled "Caracterización de la flota mexicana de vehículos". The objective of this study was to characterize the composition of the fleet of heavy vehicles, define energy efficiency indicators, and evaluate the costs and benefits to the fleet operator derived from the use and possession of heavy duty vehicles. The study fed in to the climate change analysis to improve the data on this important sector.

This study involved face-to-face interviews with 599 fleets of which 86 owned/used 4,819 Class 8 heavy duty highway tractors. A further analysis in 2012 focused on the "long tail" of small fleets and owner operators. It involved 318 operators/fleets of which 46 owned a total of 2856 Class 8 highway tractors.

The studies are publicly available and their data nicely complement the field work of the DataMac series for many of the answers required in the present study.

GIZ Scrappage Study

This 2014 two-part study performed by TSTES looked at commercial vehicle scrappage programs in Mexico, and compared to those in other countries. As such it provides an important insight into the operation of these programs and what would be needed to make them more effective.

The study involved interviews with all the scrappage centers in Mexico (that handled heavy duty vehicles) looking at the process, paperwork involved, prices, publicity, control by SHCP-SAT, SCT, SEMARNAT, other Federal and State authorities. It investigated the number of vehicles that had gone down this route, the complexity for the vehicle owner and the involvement of OEM Distributors in the scrappage schemes. It looked at the financial viability of the existing scrappage programs and how this could be improved.

The studies are also publicly available and provide useful input to some of the questions posed in this study.

c) New field survey and interview data

Whilst the information described above provides answers to many of the questions in this study, additional field work was required (i) to fill gaps, (ii) refresh some of the older information, and (iii)

validate where previous findings are still functional. This was conducted in a series of face-to-face interviews as described below:

1. Person-to-person interviews with a sample of fleets and small operators to quantify responses.
2. Person-to-person interviews with other stakeholders to capture their opinion on the wide range of themes covered by this work.

Whilst the fleet survey (item 1 above) were structured to quantify results, an open interview guide was used with the others (item 2 above), to generate mainly qualitative information.

How the active population of Highway Tractors was determined

The registered population of vehicles taken from the emission of license plates may give valid numbers for the total parc in existence, but cannot give information on those that are really in active use. For this, other data sources are needed.

TSTES has conducted a detailed study of the heavy duty fleet utilization (including Class 8 highway tractors and trailers) and repair practices in Mexico every four years since 1992 for Mackay & Company, Lombard, Illinois who provide it to heavy duty vehicle manufacturers and component suppliers. The study is highly detailed and extensive, involving complex questionnaires of around 11 pages containing questions relating to around 300 different component categories containing 1130 discrete variables. It requires person-to-person interviews of different managers within each fleets' organization to validate from their records vehicle usage and maintenance practices. This information is analyzed by fleet vocation, size of fleet, type, and age of vehicle.

The most recent study was 2015. MacKay is permitting us to share the vehicle fleet data from this study with you provided that it is referenced (cited) to Mackay & Co.[65]

The use of these findings is important because it is the only study that clearly identifies the actual active in-use vehicle fleet, as compared to the license plate statistics collated by SCT of registered heavy duty vehicles.

The study involves a very detailed face-to-face interview with 370[66] fleets of all sizes distributed in 9 localities (see Table 74) and 8 vocations (see Table 75). Of these in 2015, 132 fleets own/operate a total of 7,370 Class 8 Highway Tractors. The other fleets in the sample operated heavy duty vehicles but not Class 8 Highway Tractors. Figure 55 shows the number of fleets in this sample by fleet size.

[65] Please cite as Source: Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015
[66] The number of interviews shown for face-to-face and telephone are from the 2015 study results

Table 74 - Face-to-face Interview distribution

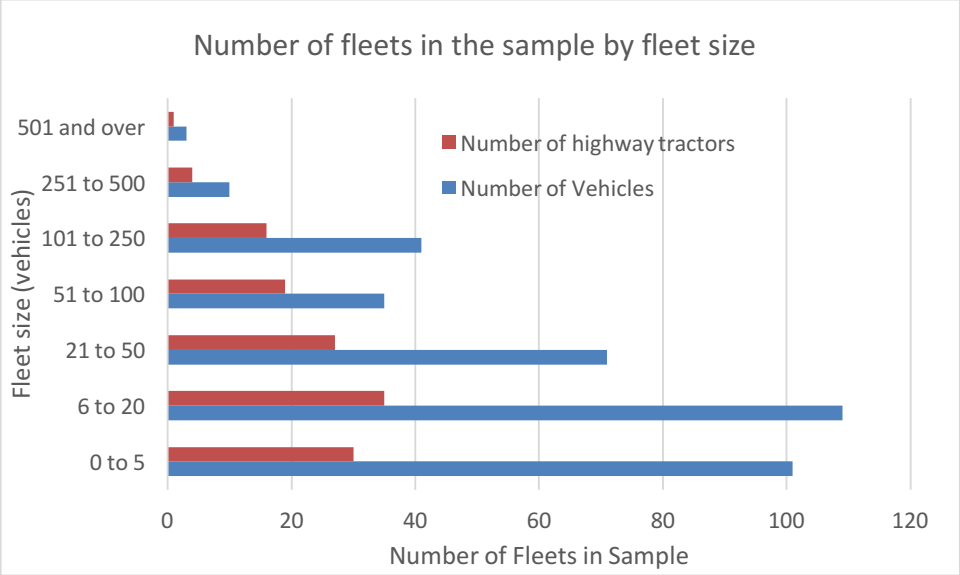
City	State
DF and ZMVM	DF and Mexico
Monterrey	Nuevo León
Guadalajara	Jalisco
Torreón	Coahuila
León	Guanajuato
Tijuana	Baja California
San L. Potosí	San Luis Potosí
Nuevo Laredo	Tamaulipas
Jalapa y Coatzacoalcos	Veracruz

Source: TSTES study for Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015

Table 75 - Vocation

Segment
Owner-operator
For Hire - General Freight
Industry and Commerce
Construction and Mining
Agriculture
Government
Bus and Coach Operators
Others

Source: TSTES study for Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015



Source: TSTES study for Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015

Figure 55 - Number of fleets in the sample by fleet size (DataMac 2015)

This study is complemented by an additional simpler telephone interview with 4,210 fleet operators (sampled from TELMEX records) distributed nationally across 32 states. This extensive, telephone survey of fleet operators enables estimation of the active in-use heavy duty vehicle population in Mexico by vocation, vehicle type, and fleet size based on real numbers from a significantly large sample of fleets (see Table 76).

Table 76 - Telephone Interviews by Category

Segment	Telephone Interviews
General Freight	1386
Industry and Commerce	992
Construction and Mining	848
Bus Operators (urban, suburban, school and company service)	664
Coach operators	320

Source: TSTES study for Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015

The study generates a smaller in-use population than that given by SCT's registration numbers as it is based on the number (and age) of vehicles that each fleet reports to be using in active service. The calculation mechanism to extrapolate survey results to national figures is based on the premise that every active fleet has at least one associated telephone number.

The resultant parc (186,000 units) is 70 percent of the registered vehicles. Its distribution by vocation and fleet size is shown in Table 77. Note that the fleet sizes shown in this table are for the number of motorized Class 6, 7, and 8 goods vehicles in the fleet (rigid trucks and highway tractors). The number of trailers and semi-trailers that each fleet owns/uses is not included.

Table 77 - - Active parc of Highway Tractors in 2015 (MacKay study)

Number of Highway Tractors per Vehicle Fleet in Mexico -April, 2015

Vocation	Fleet Size					
	1–20	21–50	51–100	101–300	>300	Total
Owner/Operator	5,230	0	0	0	0	5,230
For Hire	2,084	7,039	12,882	32,190	59,579	113,775
Industry & Commerce	1,749	4,846	11,913	15,648	15,254	49,410
Construction & Mining	2,241	1,025	1,582	2,635	1,616	9,100
Agriculture	1,283	1,331	2,651	1,744	0	7,010
Government	412	1,003	95	159	72	1,741
Total	12,999	15,245	29,124	52,377	76,521	186,266

Source: Mackay & Company, Lombard, Illinois – DataMac-Mexico 2015

The MacKay series is one of the largest heavy-duty vehicle studies in Mexico. It provides useful in-use fleet information that can be complemented by other study results from TSTES that are available for this

analysis (INECC, 2011 and GIZ, 2014). However, additional field work was required to provide answers to some of the specific questions posed.

Accordingly, a survey was conducted of 44 fleets to fill these data gaps. Whilst not statistically representative of the total parc, this analysis of 19 mid-size to large fleets, and 25 small, or owner-driver operations gives some interesting insights, as shown below. Figure 56 shows how the 44 fleets in the sample are configured by the number of highway tractors in each fleet.

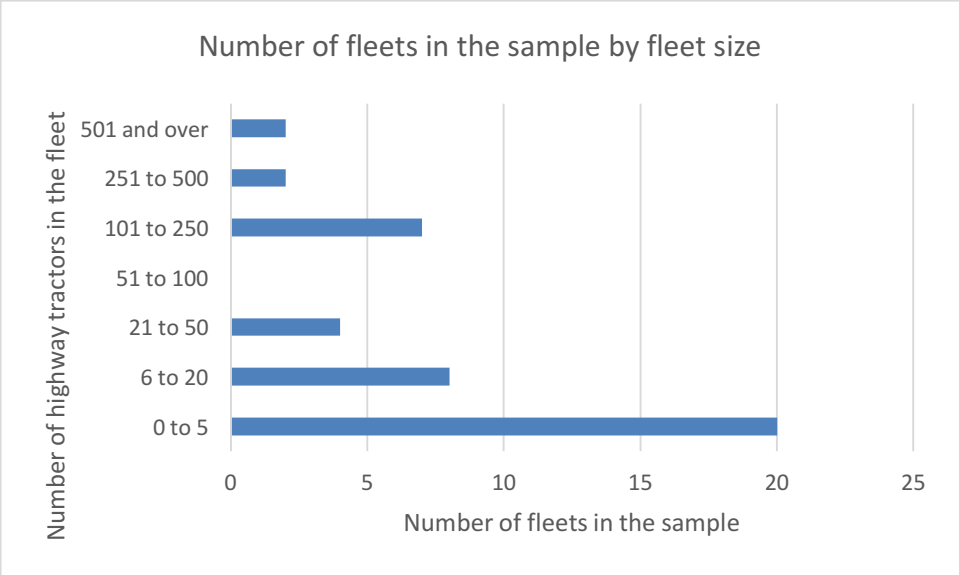


Figure 56 - Number of fleets in the sample by fleet size (ICCT survey)

All the uncited tables and graphs come from this ICCT study. The results are interposed with information from the previous work—which are all directly cited to their corresponding studies.

Active population of Highway Tractors in the current survey

The ICCT survey covered fleets that between them have 4650 highway tractors in operation, split primordially between “For Hire” transport fleets that transport other people’s goods and “Industry and Commerce” that transport their own goods. The complete list of vocational classes used in this analysis was given inTable 75 and Table 78 shows the number of highway tractors in the sample by vocation and by model year. Over half of the sample were found to be of 2013 or more recent model year.

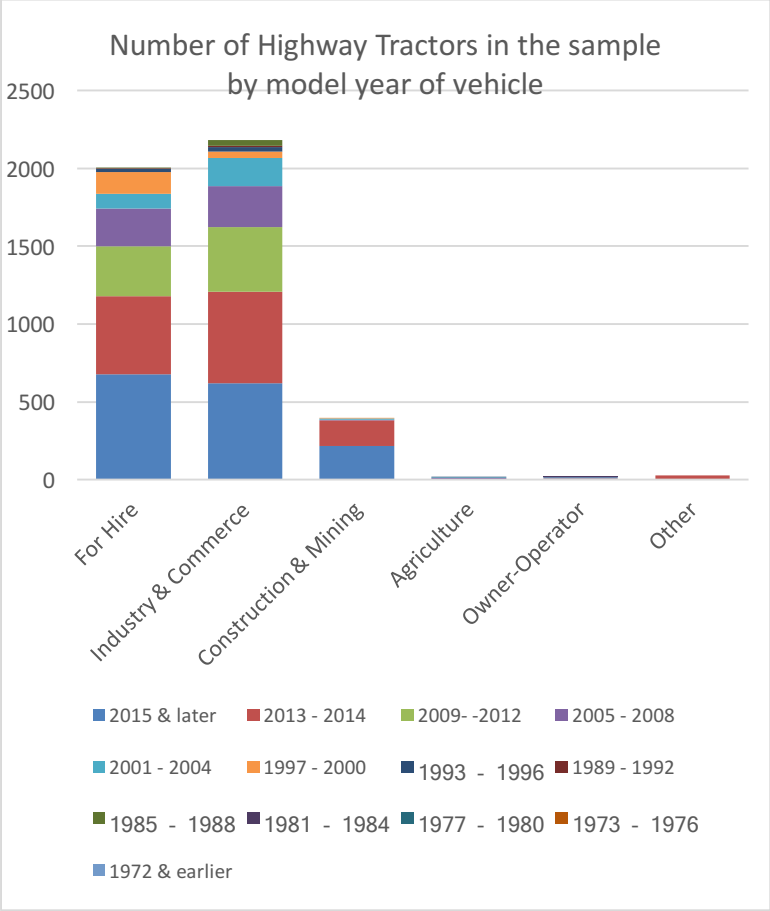


Figure 57 - Number of Highway Tractors in the sample

Table 78 - Number of Highway Tractors in the sample

Highway Tractors

Number of vehicles	For Hire	Industry & Commerce	Construction & Mining	Agriculture	Owner-Operator	Other	Total	%
2015 & later	675	620	215	0	0	1	1511	32.5%
2013 - 2014	505	588	167	2	0	25	1287	27.7%
2009- -2012	320	413	0	2	5	0	740	15.9%
2005 - 2008	243	264	3	6	9	0	525	11.3%
2001 - 2004	93	180	7	3	2	0	285	6.1%
1997 - 2000	138	41	3	0	0	0	182	3.9%
1993 - 1996	22	30	0	6	2	0	60	1.3%
1989 - 1992	6	7	0	0	0	0	13	0.3%
1985 - 1988	3	39	0	0	3	0	45	1.0%
1981 - 1984	0	0	0	0	2	0	2	0.0%
1977 - 1980	0	0	0	0	0	0	0	0.0%
1973 - 1976	0	0	0	0	0	0	0	0.0%
1972 & earlier	0	0	0	0	0	0	0	0.0%
TOTAL	2005	2182	395	19	23	26	4650	100.0%

Figure 58 shows the average number of highway tractors per fleet by model year in this (ICCT) study. Figure 59 shows for this sample, the relationship between fleet size and the average age of the highway tractors that compose the fleet. Unsurprisingly the larger fleets tend to have the newer vehicles and the oldest vehicles tend to be relegated to the smallest fleets. This is generally true for all vocations.

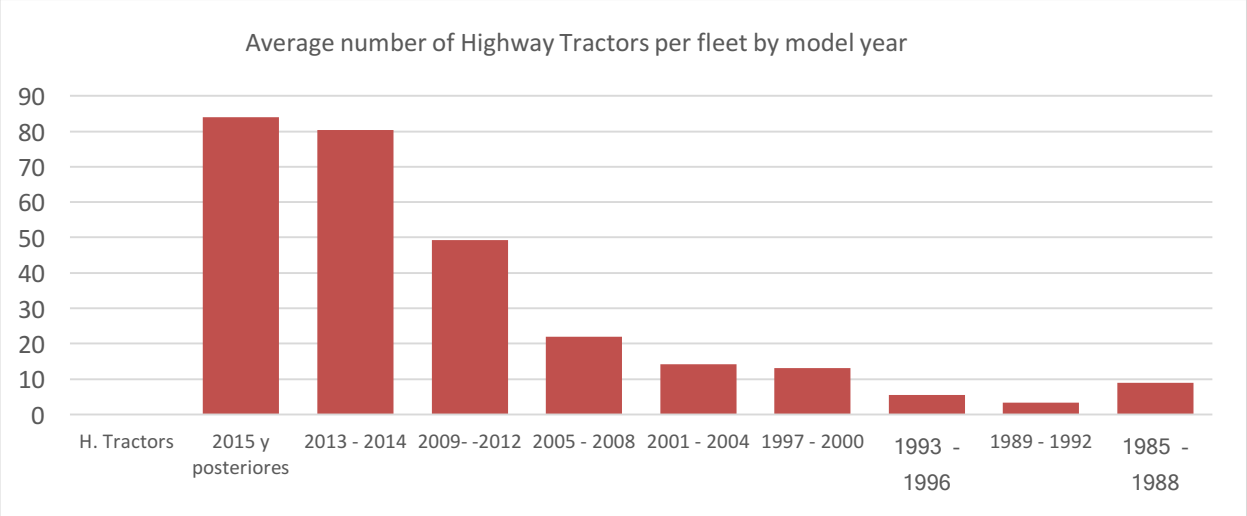


Figure 58 - Average number of Highway Tractors per fleet by model year in the sample

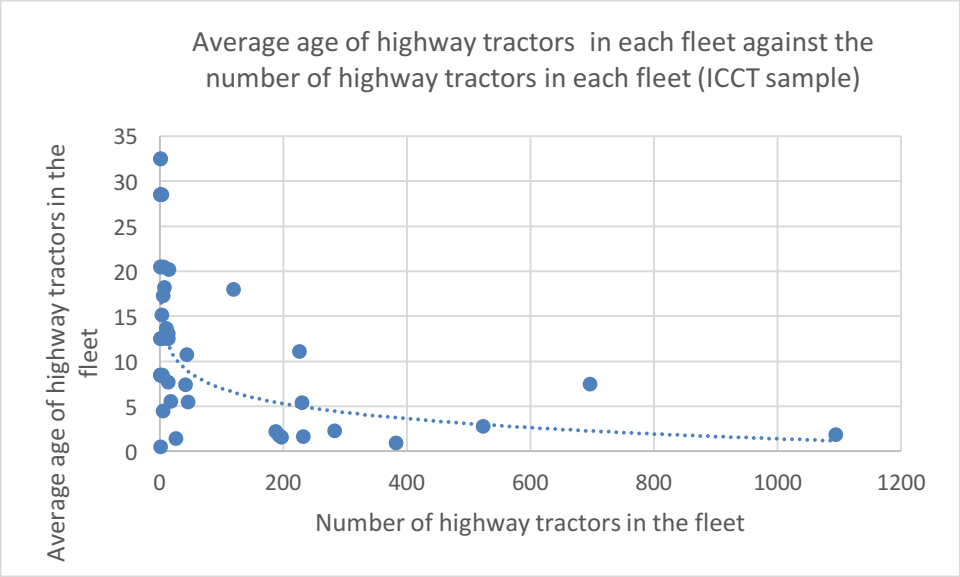


Figure 59 - Average age of highway tractors in each fleet against the number of highway tractors in each fleet (ICCT sample)

These data are from the small sample of this study, however we can use the MacKay data to quantify the total active parc.

Active population of Semi-trailers in the current survey

The MacKay series of studies are focused principally on motorized units and generate less information on semi-trailers so additional questions were covered in the ICCT survey, albeit with a smaller sample.

The fleets covered in the (ICCT) survey have a total of 9,176 semi-trailers, split primordially between "Industry and Commerce" (with 4,895 units) and "For Hire" with 3,562 units. Figure 61 and Table 79 show the number of semi-trailers in the sample by vocation and by model year. The model year range with most units is 2005 to 2008 with 2,464 semi-trailers (27 percent of the sample). Since 2012, sales have been picking back up but are still showing less in-use population than this period. Almost 80 percent of the sample were found to be of 2005 or more recent model year.

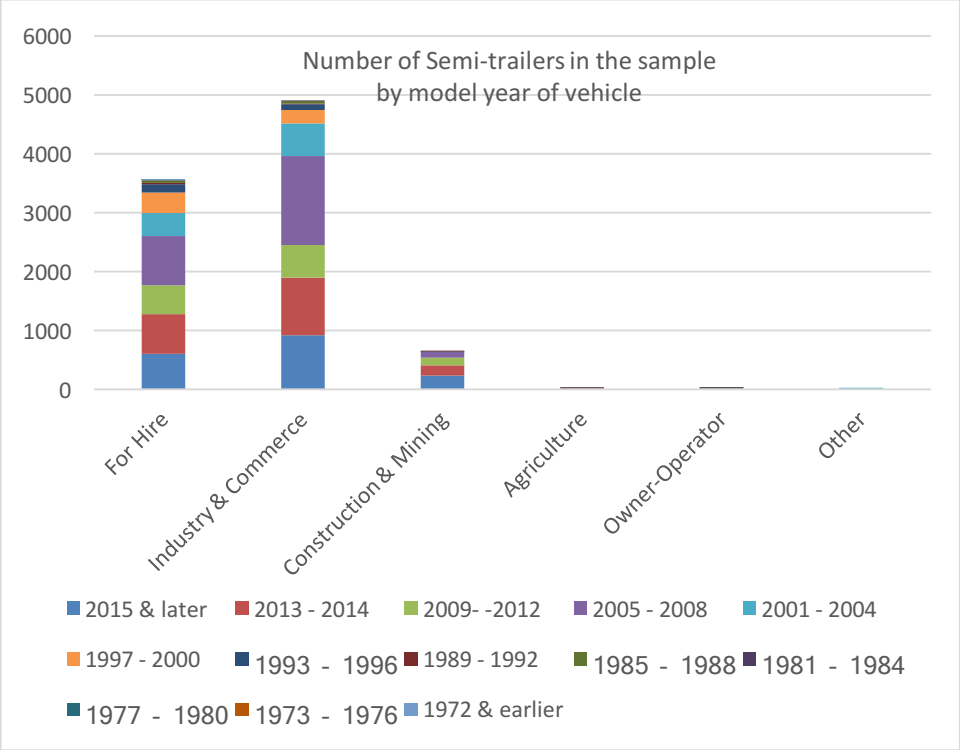


Figure 60 - Number of Semi-trailers in the sample

Table 79 - Number of Semi-trailers in the sample

Semi-trailers

Number of vehicles	For Hire	Industry & Commerce	Construction & Mining	Agriculture	Owner-Operator	Other	Total	%
2015 & later	601	920	230	0	0	2	1753	19.1%
2013 - 2014	674	973	178	0	0	6	1831	20.0%
2009- -2012	490	551	124	6	3	0	1174	12.8%
2005 - 2008	837	1518	97	4	8	0	2464	26.9%
2001 - 2004	393	546	3	4	6	16	968	10.5%
1997 - 2000	341	230	5	2	3	0	581	6.3%
1993 - 1996	145	96	3	0	1	0	245	2.7%
1989 - 1992	27	19	4	4	1	0	55	0.6%
1985 - 1988	41	41	0	3	3	0	88	1.0%
1981 - 1984	10	1	0	1	2	0	14	0.2%
1977 - 1980	2	0	0	0	0	0	2	0.0%
1973 - 1976	0	0	0	0	0	0	0	0.0%
1972 & earlier	1	0	0	0	0	0	1	0.0%
TOTAL	3562	4895	644	24	27	24	9176	100.0%

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